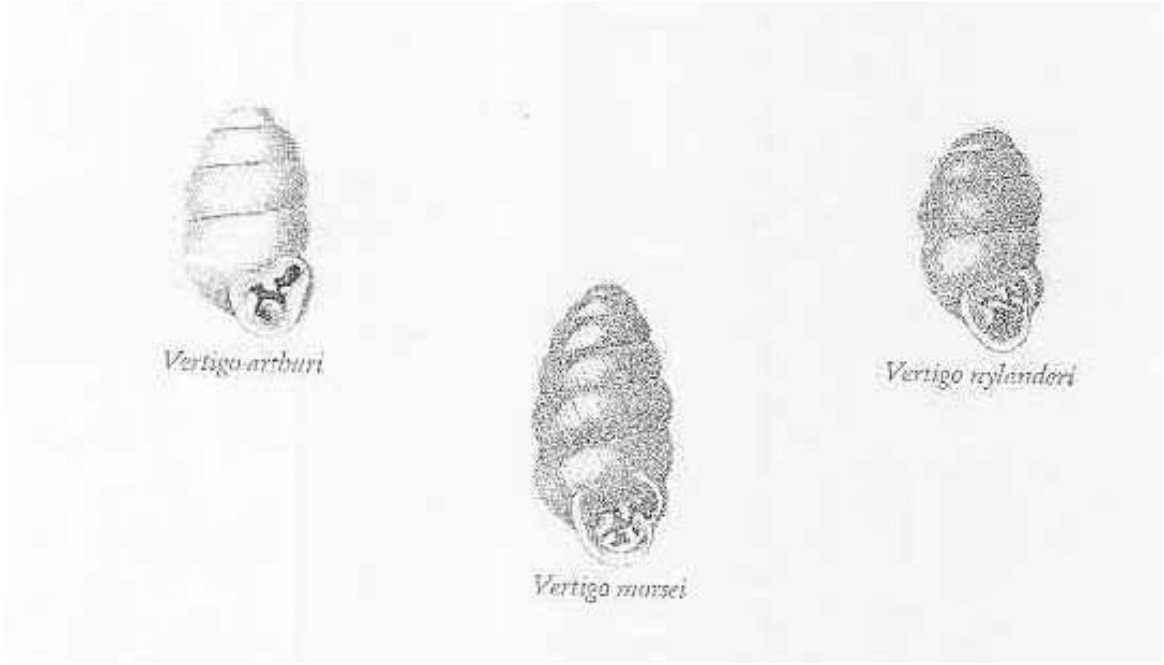
Distribution and Ecology of Terrestrial Gastropods in Northwestern Minnesota



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INTRODUCTION

Minnesota has one of the most poorly known land snail faunas in the eastern U.S. (Hubricht 1985). Prior to 1999, 60 terrestrial gastropod taxa had been reported from the state (Dawley 1955, Hubricht 1985, Ostlie 1991). Of these, only 23 had been recorded from northwestern Minnesota (Hubricht 1985).

Fully 22% of Minnesota's land snail species are rare throughout the eastern U.S. A number of these are restricted to algific slope and carbonate cliff habitats in the southeast (e.g., *Hendersonia occulta, Vertigo hubrichti, Vertigo 'iowaensis', Vertigo mermacensis*; Frest 1991). Mafic igneous outcrops and conifer wetlands in northeastern Minnesota also support a number of rarities (*Planogyra asteriscus, Vertigo cristata, Vertigo modesta modesta, Vertigo modesta parietalis, Vertigo paradoxa, Zoogenetes harpa*; Nekola et al 1999).

During the summer of 1999, a preliminary survey for land snails was conducted in northwestern Minnesota by myself and Dr. Brian Coles. We encountered 41 taxa at 12 sites scattered across Beltrami, Clearwater, Itasca, Kittson, Polk, and Roseau Counties. 20 of these were previously unreported from the region and 5 were new to the state. Some of the taxa encountered are very rare, including *Vertigo arthuri* (previously known from ca. 2 dozen sites in the Black Hills), *V. cristata* (not known to occur in the U.S. until 1996), and *V. nylanderi* (previously known from only 18 sites, and last seen in Minnesota in 1949). Not only were rare taxa encountered during this brief foray, but the diversities per site were the highest encountered at this latitude in central North America (over 20 taxa/site in some cases). The discovery of these globally rare taxa and diverse communities suggested that a more thorough inventory of the land snail fauna in this region was warranted.

Two habitats, in particular, harbored important faunas. The first was calcareous wooded peatlands dominated by tamarack, white cedar, and/or black ash. These sites harbored *Vertigo nylanderi*, which had been lost to science for almost 50 years. All previous known; recent sites were limited to northeastern Wisconsin and the Upper Peninsula of Michigan. The Minnesota populations include the largest yet discovered. More individuals were . observed at Iron Springs Bog than had previously been seen at all other extant sites. Additionally, these sites were found to harbor over 20 associated species, making them among the richest wooded peatland faunas yet encountered. Associates included the rare *Vertigo arthuri, V. cristata, V. elatior* (new to the state), *V. paradoxa*, and *Zoogenetes harpa.*

The second important habitat was aspen parkland. *Vertigo arthuri* was located at both inventoried sites, with the colony at Two Rivers SNA being perhaps the largest yet known globally. This site also supported Vertigo elatior, as well as 19 other taxa (21 total). The number of sympatic species at Two Rivers SNA was the most encountered at that time an upland woods in central North America. This richness is likely due to the highly calcareous nature of the Lake Agassiz plain.

Our cursory survey of the region in 1999 did not permit analysis of other habitats which are also likely reservoirs of land snail biodiversity. Among the more important of these are fens,

which support diverse land snail communities and very large populations in Iowa (Frest 1990), Michigan (Nekola 1998), and Wisconsin (Nekola et al 1996). These sites have been found to harbor the European disjunct Euconulus alderi, the presumed glacial relicts *Catinella exile, Vertigo elatior*, and *Vertigo morsei*, plus at least two undescribed endemic taxa (*Hawaiia* n.sp. and *Punctum* n.sp.; Frest 1990). It is very likely that other important habitats and species exist in the region. Only by investigating representative examples of all major habitat types habitats throughout the region the true extent of this fauna can be documented. The documentation of this fauna is particularly important as land snail communities are among the most sensitive known to anthropogenic and other disturbances (Frest and Johannes 1995). Because of this, such unique communities can be lost from development and agricultural pressures (Frest 1991, Nekola et al. 1996) before the full extent of their biodiversity can be assessed.

The following report summarizes findings from a land snail survey of all important natural communities found within the 14 most northwestern Minnesota counties. The large spatial and ecological extent of this analysis permits not only documentation of the distribution and abundance of individual species, in the regional fauna, but also the potential ecological patterns and processes that influence their distribution and abundance. This study represents the most extensive such survey of its kind made in North America.

METHODS:

Study Region:

A 14-county region of northwestern Minnesota was selected for analysis, including Becker, Beltrami, Clay, Clearwater, Hubbard, Kittson, Lake of the Woods, Mahnomen, Marshall, Norman, Pennington, Polk, Red Lake, and Roseau (Figure 1). This region covers 4.77 million hectares, and is of particular interest as it not only contains a wealth of calcium-rich soils, but also bisects the major plant community gradient between northern tallgrass prairie and mixedboreal forest. Five major physiographic provinces are present: Red River Valley, Aspen , Parkland, Leaf Hills, Pine Moraines, and Agassiz Lowlands.

Study Sites:

A total of 181 sites were chosen for analysis (Figure 1; Table 1). These were collected over to entire extent of the region where native plant communities still exist. For this reason, much of the western half of the Red River Valley was not sampled as it has been wholly converted to agriculture. The number of samples per county ranged from 21 (Clearwater and Polk) to 6 (Norman). Sites were selected if they represented typical examples of their respective habitat, and (except for anthropogenic habitats) were undisturbed.

Collections were made from 22 different habitat types. These habitats can be broadly grouped into four categories: upland forests, lowland forests, upland grasslands, and lowland grasslands.

Eight types of upland forest habitats were surveyed. These sites primarily differed in their canopy species, usually as a result of different soils. Oak forest (16 sites) was found on dry ridges, and often occurred in loamy or sandy soil. Maple-basswood forest (8 sites) typically occurred on hard, clay-rich soils, had thin leaf litter layers. However, some sites (especially those dominated by Basswood) possessed very deep humus layers over loamy soils. BalsamWhite Spruce forests (2 sites) were upland sites dominated by either (or both) of these northern conifers. Balsam was co-dominant at the Mahnomen County site (Oakland) with Basswood and Bur Oak. Soil letter depth was generally moderate, and bryophyte cover locally dense. Paper Birch forests (2 sites) had deep leaf litter layers, but were generally found on well-drained, gravelly soils. Aspen forests (37) were found throughout the region in a number of situations, ranging from climax forests with deep leaf litter in the Aspen Parkland, to early successional forests with thin litter in the Leaf Hills, Pine Moraines, and Agassiz lowlands. Additionally, aspen forests were found across almost the entire moisture gradient (especially in the Aspen Parkland) from wet-mesic to xeric situations. Jack Pine forests (4 sites) were limited to excessively drained, sandy soils of outwash plains. Sites were limited to the Pine Moraines and Agassiz lowlands, with most examples being seen in Hubbard and Roseau counties. Sites ranged from mesic (where oak and red maple were also present) to, xeric (where savanna developed). Hazel groves with deep leaf litter layers were found in all sites. Red Pine forest (4 sites) occurred on loamy soils, with white pine and oak also being commonly present. Leaf litter layers were generally deep, especially under hazel groves. Sites were generally limited to the Pine Moraines province. Lastly, lakeshore forests (7 sites) were sampled primarily in the Pine Moraines within a 100 km distance from Lake Itasca. While most sites were wooded, the lake margin itself was often herb-dominated. These sites were sampled via field sieving, and as such were not statistically compared with the litter collected samples.

Six types of lowland forests were surveyed. Floodplain forests (2 sites) occur on silty soils adjacent to streams and subjected to frequent flooding. Black Ash swamp forests (12 sites) were found throughout the Aspen Parkland, Leaf Hills, Pine Moraines, and Agassiz Lowlands provinces. These sites ranged from wet to mesic, with very deep, rich litter layers being found on more mesic sites. Tamarack swamp forests (24 sites) possessed a similar range, and were typically dominated by a rich bryophyte/herbaceous groundcover and alder/willow subcanopy. While surficial soil chemistry on these sites can vary from acidic (where *Sphagnum* moss is abundant) to neutral or alkaline (where *Sphagnum is* largely absent), litter collection was generally limited to the latter microsites. White Cedar swamp forests (6 sites) were limited to the Agassiz Lowlands, and often also supported black spruce and tamarack. Sites ranged from wet (with diverse bryophyte/herb groundlayers) to mesic (with little ground layer). Leaf litter depths were often great, and sites often had cool soils. Black spruce swamp forests (3 sites) were found in the Agassiz Lowlands and Pine Moraines, and typically supported a diverse bryophyte/herb ground layer. Little *Sphagnum* moss was noted in the sampled sites. Lastly, shrub-carr habitats (3 sites) were dominated by low-growing thickets of alder, willow, and dogwood, and supported a dense sedgegrass groundlayer.

Four types of upland grasslands were surveyed. These sites were all limited to the Red River Valley, Aspen Parkland, and southern Pine Moraines provinces. Mesic prairie (7 sites) are

typical tallgrass prairie sites, usually found in calcareous soils associated with the Lake Agassiz plain. Unmanaged sites often had moderately thick thatch, and fairly deep leaf litter accumulations under small shrub (leadplant, snowberry, chokecherry) clumps. Sites which had been subjected to fire management in general lacked these microsites. Xeric prairie (4 sites) was limited to gravel deposits associated with moraines and Lake Agassiz beach ridges. Litter accumulation was essentially absent except under native prairie shrubs. Sand prairie (2 sites) was found in Lake Agassiz shoreline ridges, and in outwash plains in the Pine Moraines. As with xeric prairie litter accumulation was essentially limited to microsites under native shrubs. Lastly, a single old field was sampled via field sieving. As such, the composition and abundance of snails from this site were not compared to the other habitats sampled via litter collection.

Lastly, four types of lowland grassland habitats were surveyed. Wet prairies (11 sites) are prairie areas generally found in the Red River Valley province that have saturated (or inundated) soils during at least part of the growing season. Included are brush prairies of the Aspen Parklands, which support high coverage of small willow, shrubby cinquefoil, and dogwood scrub. Unburned sites supported relatively thick thatch layers, and leaf litter accumulations under shrubs such as willows and dogwoods. Sedge meadows (3 sites) are perennially moist sites with mineral soils found throughout the region. Sedges dominate the groundlayer, with scattered clumps of willows, dogwood, and alder being commonly present. Fens (17 sites) are peatland areas with saturated soils found at sites of ground water discharge, with most sites being restricted to the Red River Valley, Agassiz Lowlands, and Pine Moraines. They maintain higher and more constant soil moisture than are otherwise found in the surrounding landscape (Nekola, 1994). Calcareous meadows (4 sites) are often sparsely vegetated wet meadows found on bare mineral (rather than organic) soils. Most of the sites were anthropogenically created through soil removal in borrow pits along roads and railroads.

Field Methods

Documentation of terrestrial gastropods from most sites was accomplished by hand collection of larger shells and litter sampling for smaller taxa from representative 100-1000 m2 areas. The latitude-longitude location for each was determined using either USGS 7.5 minute topographic maps or a hand-held GPS. Soil litter sampling was primary used as it provides the most complete assessment of site faunas (Oggier et al., 1998). As suggested by Emberton et al. (1996), litter collections were made at places of high micro-mollusc density, with a constant volume of soil litter (approximately 4 liters) being gathered from each site. For woodland sites, sampling was concentrated in areas supporting the thickest leaf litter and humus layers. For grassland sites, sampling consisted of: (1) small blocks (ca. 125 cm3) of turf; (2) loose soil and leaf litter accumulations under or adjacent to shrubs, cobbles, boulders, and/or hummocks; and (3) places with moderate to dense thatch accumulations.

However, eight sites from two habitat types (lakeshore forest and old field) were sampled only via field sieving. As data gathered from this technique are not ecologically comparable to litter sampling, these sites were used only to map species occurrence patterns. Analysis of richness and abundance patterns were limited to litter sampled sites.

Laboratory Procedures

Samples were slowly and completely dried in either in full sun in a greenhouse. Dried samples were then soaked in water for 3-24 hours, and subjected to careful but vigorous water disaggregation through a standard sieve series (ASTME 3/8" (9.5 mm), #10 (2.0 mm), #20 (0.85), and #40 (0.425 mm) mesh screens). Sieved sample fractions were then dried and passed again through the same sieve series. These dry, resorted fractions were hand picked against a neutral-brown background. All shells and shell fragments were removed.

All identifiable shells from each site were assigned to species (or subspecies) using the author's reference collection and the Hubricht Collection at the Field Museum of Natural History (FMNH). Some additional specimens representing Holarctic taxa were verified by Robert Cameron of the University of Sheffield, UK. All specimens have been catalogued and are housed in the author's collection at the University of Wisconsin -Green Bay. Nomenclature generally follows that of Hubricht (1985), with updates and corrections by Frest (1990, 1991) and Nekola (in review).

Statistical Tests

ANOVA analyses were used to determine if statistically significant differences exited in site richness and total snail abundance between sites from the four major habitat groups (upland and lowland forests, upland and lowland grasslands) and the five physiographic provinces (Red River Valley, Aspen Parkland, Leaf Hills, Pine Moraines, Agassiz Lowlands). ANOVA was also used to document the significance of differences in richness and abundance between the 20 individual habitat types sampled and the 14 surveyed counties.

The central tendencies in these relationships were graphically represented via box plots. In box plots, the central line represents the median of the sample, the margins of the box represent the interquartile distances, and the fences represent 1.5 times the interquartile distances. For data having a Gaussian distribution, approximately 99.3% of the data will fall inside of the fences (Velleman & Hoaglin, 1981). Outliers falling outside of the fences are shown with asterisks.

Linear regression was used to describe the relationship between site richness and total abundance. Analyses were conducted separately on raw abundance and natural-log transformed abundance.

An approximation of the spatial distribution of site richness and snail abundance per sample across the study region was calculated through the interpolation technique of block kriging (Burgess and Webster 1980).

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Contingency table analyses were used to assess which taxa differed in their occurrence frequencies among the four major habitat groups, and between the five physiographic provinces. The number of occurrences and absences for each taxon within each habitat group/province was then calculated. As observed frequencies of taxa were often sparse (< 5) in more than one-fifth of the areas, Fisher's Exact Test (Zar 1984) was used to identify significant differences in occurrence frequencies. Because this test was repeated on each of the 54 taxa, a Bonferroni correction was used to adjust the significance threshold to p=0.000926.

Lastly, the proportion of individuals from each species within the total encountered was calculated. These proportions were natural log-transformed, and then placed in rank order from largest to smallest. A dominance-diversity curve was then plotted by graphing transformed frequency vs. rank order. This same process was also repeated individually for each of the four major habitat groups.

RESULTS AND DISCUSSION

Description of the fauna

54 species were located during this survey from the 181 sampled sites (Table 2). At total of 151,157 individuals were encountered, of which 134,247 were identifiable to species. The remaining 16,910 individuals represent immature Pupillidae, Succineidae, *Vallonia, Cochlicopa,* or Discus. Species found in at least 50% of sites were *Zonitoides arboreus* (159 sites), *Nesovitrea electrina* (153), *Punctum minutissimum* (130), *Gastrocopta tappaniana* (117), *Striatura milium* (117), *Strobilops labyrinthica (110), Euconulus fulvus* (108), *Nesovitrea binneyana* (99), *Discus catskillensis* (97), and *Carychium exile* (91). The ten most abundant species were *Carychium exiguum* (16082 total individuals), *Punctum minutissimum* (10800), *Carychium exile* (9781), *Strobilops labyrinthica* (9778), *Nesovitrea electrina* (8388), *Vallonia gracilicosta* (8223), *Gastrocopta tappaniana* (7709), *Striatura milium* (7527), *Nesovitrea binneyana* (5773), *Discus catskillensis* (4345). Analysis of habitat and distributional patters for each of these species follows. The data discussed for each is found in Tables 3 & 4.

1. *Anguispira alternata* (Say, 1817). This is the largest land snail (up to 20 mm diameter) in the region, where it reaches its northwestern range limit. 61 individuals were located at 14 sites, and 7 habitat types, all of which were forested. The greatest number of shells were recovered from Black Ash (28), Maple-Basswood (15), and Floodplain (11) forest habitats. While found generally throughout the region, it was most frequently encountered in the Leaf Hills (20% of sampled sites) and Pine Moraines (13.73%) and least in Prairie and Aspen Parkland (both 2.63%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Floodplain Forest	1	50.00	11	5.50
Balsam-White Spruce Forest	1	50.00	2	1.00
Maple-Basswood Forest	2	25.00	15	1.88

Black Ash Wetland	2	16.67	28	2.33
Oak Forest	2	12.50	2	0.13
Tamarack Wetland	2	7.69	2	0.08
Aspen Forest	1	2.70	1	0.03

2. *Carychium exiguum* (Say, 1822). This was the most abundant species encountered in the region, with 16,082 shells being recovered from 85 sites in 15 habitat types. Populations significantly favored Lowland Forests and Lowland Grasslands, with occurrence frequency being highest in Shrub Carr, Sedge Meadow, Fen (100% of sites), Tamarack Wetland (88.46%), Black Ash Wetland (83.33), and Calcareous Meadow (75%) habitats. The largest average populations were found in Fen (421.76 shells/sample), Shrub Carr (364.33), and Sedge Meadow (336.67) habitats. While found in all counties, its distribution showed a nonsignificant ($p=0.034423$) trend toward being most frequently encountered in the Agassiz Lowlands (64.1% of sites), Aspen Parkland (50%), and Prairie (47.37%), and least in the Leaf Hills (20%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Fen	17	100.00	7170	421.76
Shrub Carr	3	100.00	1093	364.33
Sedge Meadow	3	100.00	1010	336.67
Tamarack Wetland	23	88.46	3512	135.08
Black Ash Wetland	10	83.33	1143	95.25
Calcareous Meadow	3	75.00	174	43.50
Black Spruce Wetland	2	66.67	212	70.67
White Cedar Wetland.	3	50.00	354	59.00
Sand Prairie	1	50.00	1	0.50
Wet Prairie	5	45.45	892	81.09
Mesic Prairie	2	28.57	15	2.14
Red Pine Forest	1	25.00	1	0.25
Aspen Forest	8	21.62	471	12.73
Maple-Basswood Forest	1	12.50	27	3.38
Oak Forest	1	6.25	7	0.44

3. *Carychium exile* H.C.Lea, 1842. 9781 individuals were encountered from 91 sites and 16 habitat types. This species demonstrated a highly significant ($p < 0.000005$) preference for upland and lowland forested sites. It was most frequently encountered in Maple-Basswood, Balsam-White Spruce, Floodplain (present at 100% of sites), Oak (87.5%), Black Ash (83.33), White Cedar (83.33), and Red Pine (75%) forests. The largest populations were found in Black Ash wetlands (283.08 individuals/sample), Sedge Meadows (126.33), and White Cedar wetlands (91.83). Although found in all counties, this species was encountered with significantly ($p < 0.000005$) higher frequency in the Leaf Hills (86.67% of sites), as compared to the Red River Valley (10.53%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Maple-Basswood Forest	8	100.00	638	79.75
Balsam-White Spruce Forest	2	100.00	91	45.50
Floodplain Forest	2	100.00	82	41.00
Oak Forest	14	87.50	570	35.63
Black Ash Wetland	10	83.33	3397	283.08
White Cedar Wetland	5	83.33	551	91.83
Red Pine Forest	3	75.00	102	25.50
Sedge Meadow	2	66.67	379	126.33
Aspen Forest	22	59.46	2505	67.70
Paper Birch Forest	1	50.00	23	11.50
Tamarack Wetland	12	46.15	1050	40.38
Black Spruce Wetland	1	33.33	58	19.33
Shrub Carr	1	33.33	41	13.67
Jack Pine Forest	1	25.00	4	1.00
Fen	2	11.76	239	14.06
Wet Prairie	1	9.09	51	4.64

4. *Catinella avara* (Say, 1824). 709 individuals of this species were encountered at *43* sites and *12* habitat types. Populations were significantly (p=0.000142) more frequent in grassland (43-49%) as compared to forested (13-19%) sites. Populations were most often encountered in Mesic (85.71% of sites) and Wet Prairie (81.82). Populations were also largest in these sites (35.71 and 21.45 individuals/sample, respectively). Although found in all counties but Hubbard, populations appeared more common to the southwest. A non-significant (p=0.001367) trend in distribution was present, with populations occurring most frequently in the Red River Valley (47.37% of sites), but being absent from the Leaf Hills.

Habitat	Occurrences	% Frequency	# Individuals	Average
Mesic Prairie	6	85.71	250	35.71
Wet Prairie	9	81.82	236	21.45
Calcareous Meadow	2	50.00	25	6.25
Black Spruce Wetland	1	33.33	14	4.67
Shrub Carr	1	33.33	3	1.00
Sedge Meadow	1	33.33	3	1.00
Fen	5	29.41	86	5.06
Black Ash Wetland	3	25.00	12	1.00
Tamarack Wetland	5	19.23	25	0.96
Aspen Forest.	5	13.51	48	1.30
Maple-Basswood Forest	1	12.50	6	0.75
Oak Forest	1	6.25	1	0.06

5. *Catinella exile* (Leonard, 1972). Diagnostic characteristics are based on Frest (1990), who noted that the shell of this species is smaller, has a higher spire, and is more orange-colored than Catinella avara. Described from Pleistocene material, it was previously thought extant only from fens in Iowa (Frest, 1990) and the western Great Lakes (Nekola, in review). 2604 individuals were located at 11 sites and 3 habitat types. All but 7 of these were found at 9 fen sites, where average number of encountered shells per sample was 152.76. Populations were essentially limited to the Red River Valley and Aspen Parkland regions, although this distributional trend was only marginally significant (p=0.003291). Given the small number of populations encountered, and their almost complete limitation to high-quality fens, consideration for state listing of this species seems warranted.

Habitat	Occurrences	% Frequency	# Individuals	Average
Fen	9	52.94	2597	152.76
Black Ash Wetland	1	8.33	6	0.50
Tamarack Wetland	1	3.85	1	0.04

6. *Catinella* cf. *vermeta* (Say, 1829). This small (< 5 mm tall) *Catinella* with a deep suture was limited to a single xeric prairie site (Felton Prairie), where *2* individuals were located. The treatment of these specimens follows that of Frest & Dickson (1986), who related a small *Catinella* from xeric Loess Hill prairies in western Iowa to this taxon. Seemingly identical individuals have also been found on xeric carbonate glades in northeastern Iowa and southeastern Minnesota (Nekola*,* 1999).

Habitat	Occurrences	% Frequency	# Individuals	Average
Xeric Prairie	1	25.00	2	0.50

7. *Cochlicopa lubrica* (Müller, 1774). Based upon the morphometric analyses of Preece *(1992), I* am using this name to designate individuals with shell heights > 6 mm and widths > *2.3* mm. I have also chosen European convention (e.g. Kerney & Cameron, *1979)* in using *Cochlicopa,* rather than *Cionella,* for the generic name (see Turgeon et al., *1998). As* defined, *1888* individuals of this taxon were located at *24* sites and 11 habitat types. A non-significant *(p*=0.031594) trend was noted in habitat preference with populations tending to favor lowland forests (25% of sampled sites) while being absent from upland grasslands. Populations were most frequently encountered in Floodplain Forests (100% of surveyed sites) and Black Ash wetlands (41.67%). Largest average population sizes were noted in Sedge Meadow (99.33 individuals/sample), Black Ash wetland (75.5), and floodplain forests (41.5). Although data collected do not permit testing, it appeared that populations were most frequently encountered in sites with thin leaf litter and hard clay soils, or which had been subjected to anthropogenic disturbance. Although scattered throughout, populations appeared somewhat more common in the north and west of the region.

Habitat	Occurrences	% Frequency	# Individuals	Average
Floodplain Forest	2	100.00	83	41.50
Black Ash Wetland	5	41.67	906	75.50
Black Spruce Wetland	1	33.33	75	25.00
Shrub Carr	1	33.33	19	6.33
Sedge Meadow	1	3.33	298	99.33
Oak Forest	4	25.00	108	6.75
Maple-Basswood Forest	2	25.00	256	32.00
Calcareous Meadow	1	25.00	8	2.00
Tamarack Wetland	4	15.38	17	0.65
Wet Prairie	1	9.09	26	2.36
Aspen Forest	2	5.41	92	2.49

8. *Cochlicopu lubricella* (Porro, 1838). Kerney and Cameron (1979), Hubricht (1985), and Preece (1992) are followed in designating those mature individuals with shells < 2.3 mm wide and < 6 mm tall as this taxon. Additional morphometric and genetic analysis of this group is warranted, as individuals with various intermediate shell dimensions were consistently encountered. 2653 individuals of this taxon, as so defined, were located at 89 sites and 18 habitats. Populations were significantly ($p < 0.0000005$) more frequent in forested as compared to grassland sites (52-68% vs. 14-17%, respectively). This species was most frequently found in Balsam-White Spruce, Paper Birch (both 100% of sites) Maple-Basswood forest (87.50), Black Ash wetland (83.33%), and Aspen forest (72.97%). The largest populations were observed in Black Ash wetland (67.75 individuals/sample), Maple-Basswood forest (32.88), Sedge Meadow (29.67), and Aspen forest (25.65) habitats. Although found through the region in all counties, it did demonstrate a non-significant ($p=0.00503$) trend by being 50-60% less frequent in the Red River Valley than other physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Balsam-White Spruce Forest	2	100.00	3	1.50
Paper Birch Forest	2	100.00	10	5.00
Maple-Basswood Forest	7	87.50	263	32.88
Black Ash Wetland	10	83.33	813	67.75
Aspen Forest	27	72.97	949	25.65
Oak Forest	11	68.75	132	8.25
White Cedar Wetland	4	66.67	44	7.33
Floodplain Forest	1	50.00	10	5.00
Sand Prairie	1	50.00	22	11.00
Tamarack Wetland	10	38.46	180	6.92
Wet Prairie	4	36.36	43	3.91
Black Spruce Wetland	1	33.33	2	0.67
Shrub Carr	1	33.33	10	3.33
Sedge Meadow	1	33.33	89	29.67

Jack Pine Forest	1	25.00	10	2.50
Red Pine Forest	1	25.00	12	3.00
Calcareous Meadow	1	25.00	24	6.00
Mesic Prairie	1	14.29	37	5.29

9. *Columella simplex* (Gould, 1841). 538 individuals of this species were identified at 82 sites and 13 habitat types. Populations were significantly ($p < 0.0000005$) more frequently encountered in woodland (58-63% of sites) vs. grassland (3-7%) sites. Populations were most often found in Paper Birch, Red Pine, Floodplain forest and Black Spruce wetland (100% of sampled sites), MapleBasswood, and Jack Pine forest (75%). Although frequently encountered, population sizes were typically low, with the most individuals/sample being recovered from Red Pine (8.50) and Aspen forest (6.62). A likely reason for these small observed population sizes is its arboreal nature, as living individuals were most commonly found over 50 dm ,off the ground on herbs and ferns. Although found in all counties, this species demonstrated a significantly ($p < 0.0000005$) higher occurrence frequency (53-73% of sites) in the east (Agassiz Lowlands, Pine Moraines, and Leaf Hills regions), as compared to the Aspen Parkland (26%) and Red River Valley (5%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Paper Birch Forest	2	100.00	5	2.50
Red Pine Forest	4	100.00	34	8.50
Floodplain Forest	2	100.00	4	2.00
Black Spruce Wetland	3	100.00	15	5.00
Maple-Basswood Forest	6	75.00	42	5.25
Jack Pine Forest	3	75.00	9	2.25
White Cedar Wetland	4	66.67	11	1.83
Oak Forest	10	62.50	58	3.63
Black Ash Wetland -	7	58.33	55	4.58
Aspen Forest	20	54.05	245	6.62
Tamarack Wetland	14	53.85	54	2.08
Balsam-White Spruce Forest	1	50.00	2	1.00
Fen	1	5.88	4	0.24

10. *Deroceras* spp. Due to the nature of field collection techniques, live slugs were only infrequently observed. However, 160 internal plates from Deroceras were found at 46 sites and 14 habitat types. Observation of living individuals suggests that many of the lowland populations represent the native Deroceras laeve (Müller, 1774), while upland populations represent the introduced Deroceras reticulatum (Müller, 1774). Populations tended ($p=0.001077$) to favor lowland forests and grasslands (33-46% of sites) as opposed to upland sites (7-15%). Populations were most frequently encountered in Wet Prairie (72.73%), Shrub Carr (66.67), BalsamWhite Spruce, and Floodplain forests (both 50%). The largest populations were encountered in Fen (3.76 individuals/sample) and Shrub Carr (3) habitats.

Although absent only from Hubbard County, populations tended (p=0.01) to be more frequent to the north and west, especially in the Red River Valley.

Habitat	Occurrences	% Frequency	# Individuals	Average
Wet Prairie	8	72.73	12	1.09
Shrub Carr	2	66.67	9	3.00
Balsam-White Spruce Forest	1	50.00	1	0.50
Floodplain Forest	1	50.00	1	0.50
Black Ash Wetland	5	41.67	8	0.67
Fen	6	35.29	64	3.76
Black Spruce Wetland	1	33.33	2	0.67
Sedge Meadow	1	33.33	1	0.33
Tamarack Wetland	8	30.77	18	0.69
Calcareous Meadow	1	25.00	6	1.50
Oak Forest	3	18.75	5	0.31
Mesic Prairie	1	14.29	2	0.29
Aspen Forest	5	13.51	30	0.81
Maple-Basswood Forest	1	12.50	1	0.13

11. *Discus catskillensis* (Pilsbry, 1898). Although usually considered distinct from Discus *cronkhitei* (Hubricht 1985, Turgeon et al., 1998), many individuals from many sites in the region proved to have shells with shapes intermediate between these two. Similar intergradation has also been noted in northeastern Minnesota, southern Ontario, and the Keweenaw Peninsula, suggesting that Pilsbry (1948) may have been correct in considering *D. catskillensis* a subspecies of *D. cronkhitei*. In deference to the current taxonomic treatment, and because of the lack of objective data to test morphometric such hypotheses, I have chosen to maintain these taxa as separate, with *D. catskillensis* representing those individuals possessing a more angular (as opposed to more rounded) body whorl margins. Based on this criteria, 4345 individuals were observed from 97 stations in 16 habitat types. Populations were significantly ($p < 0.0000005$) less frequent in grassland (0-17% of sites) as opposed to forest (58-76%) sites. Populations were most frequently encountered in Balsam-White Spruce, Paper Birch, Red Pine Forest, White Cedar, Black Spruce (found at 100% of all sites), Oak (87.5%), Aspen (78.38), Maple-Basswood, and Jack Pine (75%) forests. The largest populations were encountered in Jack Pine forest (62 individuals/sample), Black Ash wetland (50.5), Red Pine forest (49), Sedge Meadow (48), and Oak forest (45.31). Although found in every county, populations were significantly (p=0.00001) less frequent in the Red River Valley (21% of sites) as opposed to the other regions (50-87%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Balsam-White Spruce Forest	2	100.00	71	35.50
Paper Birch Forest	2	100.00	28	14.00
Red Pine Forest	4	100.00	196	49.00

White Cedar Wetland	6	100.00	182	30.33
Black Spruce Wetland	3	100.00	85	28.33
Oak Forest	14	87.50	725	45.31
Aspen Forest	29	78.38	1181	31.92
Maple-Basswood Forest	6	75.00	245	30.63
Jack Pine Forest	3	75.00	248	62.00
Sedge Meadow	2	66.67	144	48.00
Floodplain Forest	1	50.00	84	42.00
Black Ash Wetland	6	50.00	606	50.50
Tamarack Wetland	13	50.00	521	20.04
Shrub Carr	1	33.33	8	2.67
Fen	3	17.65	20	1.18
Wet Prairie	1	9.09	1	0.09

12. *Discus cronkhitei* (Newcomb, 1865). 2083 individuals of this species were located from 83 sites in 15 habitat types. Populations tended ($p=0.002597$) to be twice as frequent in lowland (58-63% of sites) as opposed to upland (21-35%) habitats. It was most frequently encountered in Floodplain forest, Shrub Carr, Sedge Meadow (all 100%), Wet Prairie (72.73%), and White Cedar wetlands (66.67%). Largest populations were encountered in Shrub Carr (57.33 individuals/sample), Black Ash wetland (56.83), and Fen (45.35) habitats. Populations were found in all counties, and occurred in equal proportions among all physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Floodplain Forest	2	100.00	18	9.00
Shrub Carr	3	100.00	172	57.33
Sedge Meadow	3	100.00	7	2.33
Wet Prairie	8	72.73	92	8.36
White Cedar Wetland	4	66.67	37	6.17
Fen	11	64.71	771	45.35
Tamarack Wetland	14	53.85	123	4.73
Balsam-White Spruce Forest	1	50.00	1	0.50
Black Ash Wetland	6	50.00	682	56.83
Aspen Forest	16	43.24	107	2.89
Mesic Prairie	3	42.86	45	6.43
Black Spruce Wetland	1	33.33	1	0.33
Oak Forest	5	31.25	22	1.38
Maple-Basswood Forest	2	25.00	4	0.50
Jack Pine Forest	1	25.00	1	0.25

13. *Euconulus alderi* (Gray, 1840). First reported in North America from Iowa fens (Frest, 1990), this species has been found throughout the Great Lakes region in fens, tamarack swamp forests, and white cedar wetlands. Its mature shells are most easily distinguished from *Euconulus fulvus* by being < 2.8 mm in diameter, having a darker-orange color, more glassy

luster, and possessing spiral lines on the bottom that are more distinct than the transverse lines (Kerney & Cameron, 1979). Live material was verified as representing this taxon in 1999 by Robert Cameron. Although not morphometrically tested, it also appeared that the width of the nuclear whorl for E. alderi was slightly larger than that for E. fulvus. However, in North America E. alderi and E. fulvus are less distinct than in western European populations, with intermediate individuals being occasionally observed. Based on these criteria, 3094 individuals were observed from 82 sites and 11 habitat types. Populations demonstrated a strong ($p < 0.0000005$) preference for lowland (77-91%) vs. upland (9-21%) sites. Populations were most frequently encountered in Black Spruce wetland, Shrub Carr, Sedge Meadow, Fen (all 100% of sites), Tamarack Wetland (92.31%), Wet Prairie (81.82%) and Calcareous Meadow (75%) habitats. The largest populations were observed in Shrub Carr (93 individuals/site) and Fen (81.12) sites. Populations were found in all counties, and showed no significant difference in occurrence frequencies between physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Black Spruce Wetland	3	100.00	52	17.33
Shrub Carr	3	100.00	279	93.00
Sedge Meadow	3	100.00	132	44.00
Fen	17	100.00	1379	81.12
Tamarack Wetland	24	92.31	318	12.23
Wet Prairie	9	81.82	343	31.18
Calcareous Meadow	3	75.00	230	57.50
White Cedar Wetland	4	66.67	37	6.17
Black Ash Wetland	6	50.00	186	15.50
Mesic Prairie	3	42.86	8	1.14
Aspen Forest	6	16.22	130	3.51

14. *Euconulus fulvus* (Müller, 1774). 2231 individuals were located from 108 sites and 18 habitat types. Populations were significantly ($p < 0.0000005$) more frequent in upland forests (98.75% of surveyed sites) as compared to lowland forests (38%), upland grasslands (43%), and lowland grasslands (9%). Populations were most frequently encountered in Oak, MapleBasswood, Balsam-White Spruce, Paper Birch, Jack Pine, Red Pine, Floodplain (all 100% of surveyed sites), Aspen (97.3%), and Black Ash (75%) forests. The largest populations were found in Aspen (29.08 individuals/site), Maple-Basswood Forest (26.5), Oak (23.94), Red Pine (16.5) and Jack Pine (14.75), forests. Although found in all counties, populations tended ($p=0.006493$) to be less common in the Red River Valley (37% of sites) as compared to the other regions (54-80%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Oak Forest	16	100.00	383	23.94
Maple-Basswood Forest	8	100.00	212	26.50
Balsam-White Spruce Forest	2	100.00	13	6.50

Paper Birch Forest	2	100.00	8	4.00
Jack Pine Forest	4	100.00	59	14.75
Red Pine Forest	4	100.00	66	16.50
Floodplain Forest	2	100.00	9	4.50
Aspen Forest	36	97.30	1076	29.08
Black Ash Wetland	9	75.00	134	11.17
White Cedar Wetland	3	50.00	47	7.83
Xeric Prairie	2	50.00	34	8.50
Sand Prairie	1	50.00	11	5.50
Mesic Prairie	3	42.86	68	9.71
Black Spruce Wetland	1	33.33	18	6.00
Sedge Meadow	1	33.33	23	7.67
Calcareous Meadow	1	25.00	1	0.25
Tamarack Wetland	5	19.23	58	2.23
Wet Prairie	1	9.09	11	1.00

15. *Gastrocopta abbreviata* (Sterki, 1909). This primarily western species was only observed from two sites: a wet prairie (Malmberg Prairie in Polk County) and an old field (at Lake Itasca State Park in Clearwater County). As this latter site was collected via field sieving, it was not included for ecological analysis. This species differs from the similar Gastrocopta similis by having a peg-shaped columellar lamella, a well-defined basal lamellae, and by having both palatal lamellae originate at the same distance from the aperture. The presence of this species in a disturbed old field makes it likely that it occurs in additional such sites throughout the region. As such, listing of this species does not seem warranted.

Habitat	Occurrences	% Frequency	# Individuals	Average
Wet Prairie	1	9.09	1	0.09

16. *Gastrocopta contracta* (Say, 1822). 974 individuals of this species were observed from 47 sites and 12 habitat types. This species tended ($p=0.049078$) to be at least half as frequent in upland grasslands as the other three major habitat types. It was most frequently encountered in Maple-Basswood forest (75% of sites), Shrub Carr (66.67%), Oak forest (56.25%), and Balsam-White Spruce forest (50%). The largest populations were recorded from Sedge Meadow (32.67 individuals/sample), Black Ash wetland (20.25), Shrub Carr (15.67), and Maple-Basswood forest (12.13). This species was restricted to the southwestern 2/3 of the region, being absent from the bulk of Beltrami, Lake of the Woods, and Roseau counties. A significant ($p < 0.0000005$) variation among physiographic regions was observed, being most common in the Leaf Hills (67% of sites) but absent from the Agassiz lowlands.

Habitat	Occurrences	% Frequency	# Individuals	Average
Maple-Basswood Forest	6	75.00	97	12.13
Shrub Carr	2	66.67	47	15.67

Oak Forest	9	56.25	80	5.00
Balsam-White Spruce Forest	1	50.00	2	1.00
Black Ash Wetland	5	41.67	243	20.25
Sedge Meadow	1	33.33	98	32.67
Wet Prairie	3	27.27	22	2.00
Aspen Forest	10	27.03	236	6.38
Xeric Prairie	1	25.00	13	3.25
Calcareous Meadow	1	25.00	21	5.25
Fen	4	23.53	65	3.82
Tamarack Wetland	2	7.69	50	1.92

17. *Gastrocopta holzingeri* (Sterki, 1889). 2752 individuals were recovered from 53 sites and 11 habitat types. It demonstrated strong ($p < 0.0000005$) variation in its habitat preferences, being found in 86% of Upland Grassland, but only 2% of Lowland Forest sites. It was also relatively frequent (41%) in upland forest. It was most commonly encountered in Xeric and Sand prairie (100% of sites), Mesic prairie (71.43%), Maple-Basswood forest, Balsam-White Spruce forest, and Calcareous Meadow (all 50%). The largest populations were encountered in Maple-Basswood forest (136.50 individuals/sample) and Xeric prairie (91.5). This species shares distributions almost identical to the previous species, being essentially limited to sites in the southwest half of the region. A significant ($p=0.000001$) variation was noted in occurrence frequency between physiographic regions, being most common in the Red River Valley (55%), and least in the Agassiz Lowlands (5%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Xeric Prairie	4	100.00	366	91.50
Sand Prairie	2	100.00	44	22.00
Mesic Prairie	5	71.43	148	21.14
Maple-Basswood Forest	4	50.00	1092	136.50
Balsam-White Spruce Forest	1	50.00	5	2.50
Calcareous Meadow	2	50.00	28	7.00
Aspen Forest	15	40.54	797	21.54
Oak Forest	6	37.50	178	11.13
Wet Prairie	4	36.36	72	6.55
Sedge Meadow	1	33.33	12	4.00
Black Ash Wetland	1	8.33	10	0.83

18. *Gastrocopta pentodon* (Say, 1821). 1751 individuals of this species were observed at 48 sites and 8 habitat types. It demonstrated strong ($p < 0.0000005$) occurrence preference for upland forest (49% of sites), while being almost absent from grasslands (0-7%). It was most frequently encountered in Oak (68.75%) and Maple-Basswood (62.50) forest. The largest populations were found in Aspen (29.49 individuals/sample), Oak (20.19), Maple-Basswood (19.75) forest and Black Ash wetlands (11.83). Like the previous two species, populations were largely limited to the southwestern half of the study region. Significant ($p=0.000001$)

variation in occurrence frequency was noted between physiographic regions, being highest in the Leaf Hills (60%) and lowest in the Red River Valley (8%) and Agassiz Lowlands (5%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Oak Forest	11	68.75	323	20.19
Maple-Basswood Forest ,	5	62.50	158	19.75
Paper Birch Forest	1	50.00	1	0.50
Black Ash Wetland	6	50.00	142	11.83
Sand Prairie	1	50.00	1	0.50
Aspen Forest	18	48.65	1091	29.49
Red Pine Forest	1	25.00	5	1.25
Tamarack Wetland	2	7.69	30	1.15

19. *Gastrocopta similis* (Sterki, 1909). 123 individuals were observed from 6 sites and 5 habitat types. These sites represent this species northwestern range limit. It differs from the similar Gastrocopta abbreviata by having a plate-shaped columellar lamellae, lacking a basal lamellae, and by having its lower palatal lamella more deeply set from the aperture as compared to the upper palatal. Populations strongly trended ($p=0.001043$) towards favoring of grassland sites, being present in 21% up surveyed upland grasslands. Populations were most commonly encountered in Xeric Prairie (50% of sites), Calcareous Meadow (25%) and Mesic Prairie (14.29%). The largest population (74 individuals/sample) was noted in an anthropogenic Ash-Willow windbreak located next to a prairie. Populations were essentially limited to the western fourth of the study region, strongly trending ($p = 0.00534$) to be more frequent in the Red River Valley (13% of sites). Even though not common in the study region, state listing is not warranted, as this species is common and throughout bedrock glades of the southeast, with populations often exceeding 100 individuals/sample.

Habitat	Occurrences	% Frequency	# Individuals	Average
Xeric Prairie	2	50.00	13	3.25
Calcareous Meadow	1	25.00	9	2.25
Mesic Prairie	1	14.29	21	3.00
Wet Prairie	1	9.09	6	0.55
Black Ash Wetland	1	8.33	74	6.17

20. *Gastrocopta tappaniana* (C.B. Adams, 1842). 7709 individuals were located from 117 sites and 17 habitat types. It demonstrated strong ($p < 0.0000005$) preferences to lowland habitats, being found in 85% of lowland forest and 94% of lowland grassland sites, while only being encountered in 43% of upland forest and upland grassland sites. It was most frequently observed in White Cedar wetland, Black Spruce wetland, Sedge Meadow, Calcareous Meadow (100% of surveyed sites), Fen (94.12%), Wet Prairie (90.91%), Tamarack wetland (84.62%), and Black Ash Wetland (83.33%) sites. The largest populations were encountered in Fen (214.53 individuals/sample), Shrub Carr (131.33), Calcareous Meadow (88.5), Sedge Meadow (84), and

Wet Prairie (75.91). Populations were found in all counties. However, significant ($p=0.000273$) variation occurred between physiographic regions, with occurrence frequencies being highest in the Agassiz Lowlands, Aspen Parkland, and Red River Valley regions (71-82% of sites), and lowest in the Leaf Hills and Pine Moraines (33-47%).

Habitat	Occurrences	% Frequency	# Individuals	Average
White Cedar Wetland	6	100.00	112	18.67
Black Spruce Wetland	3	100.00	45	15.00
Sedge Meadow	3	100.00	252	84.00
Calcareous Meadow	4	100.00	354	88.50
Fen	16	94.12	3647	214.53
Wet Prairie	10	90.91	835	75.91
Tamarack Wetland	22	84.62	631	24.27
Black Ash Wetland	10	83.33	487	40.58
Mesic Prairie	5	71.43	126	18.00
Shrub Carr	2	66.67	394	131.33
Aspen Forest	21	56.76	766	20.70
Balsam-White Spruce Forest	1	50.00	7	3.50
Floodplain Forest	1	50.00	2	1.00
Oak Forest	6	37.50	38	2.38
Jack Pine Forest	1	25.00	1	0.25
Red Pine Forest ;	1	25.00	1	0.25
Maple-Basswood Forest	1	12.50	11	1.38

21. *Hawaiia minuscule* (A. Binney, 1840). 2896 individuals were observed from 81 sites and 15 habitat types. Populations tended ($p=0.008844$) to be more frequently encountered in grassland sites (57-71%), while being less often found in upland (45%) and lowland (29%) forests. Populations were most often located in Floodplain Forest, Mesic Prairie (both 100% of sites), Wet Prairie (72.73%), Black Ash Wetland (66.67%), Shrub Carr (66.67%), and MapleBasswood Forest (62.50%). Largest populations were noted in Sedge Meadow (105 individuals/sample), Fen (51.53), and Mesic Prairie (48.57). Populations were largely limited to the southwestern half of the region. As a result, strong ($p < 0.0000005$) variation in occurrence frequency was noted between physiographic regions, being highest in Red River Valley, Aspen Parkland, and Leaf Hills (53-76%) and lowest in the Pine Moraines and Agassiz Lowlands (13-27%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Floodplain Forest	2	100.00	20	10.00
Mesic Prairie	7	100.00	340	48.57
Wet Prairie	8	72.73	334	30.36
Black Ash Wetland	8	66.67	303	25.25
Shrub Carr	2	66.67	3	1.00

Maple-Basswood Forest	5	62.50	305	38.13
Oak Forest	9	56.25	77	4.81
Fen	9	52.94	876	51.53
Xeric Prairie	2	50.00	7	1.75
Sand Prairie	1	50.00	26	13.00
Calcareous Meadow	2	50.00	8	2.00
Aspen Forest	17	45.95	215	5.81
Black Spruce Wetland	1	33.33	56	18.67
Sedge Meadow	1	33.33	315	105.00
Tamarack Wetland	2	7.69	11	0.42

22. *Hawaiia* n.sp. This taxon was first mentioned by Frest *(*1990) during his inventory of Iowa fen land snails. It differs from the common Hawaiia miniscula by possessing a thickened apertural callus. It was initially reported from less than 2 dozen Iowa sites, and has subsequently been located at two sites in southern Wisconsin. It is limited to fen sites, and may often co-occur with H. miniscula. A single site was located in the study area from the large Felton Prairie fen. It was not present at the nearby smaller fen which had been subjected to fire management. At total of 31 individuals were observed. This site is approximately 300 miles north of the next nearest known population in northwestern Iowa. It likely occurs in Minnesota in other high quality fens. Given its strong habitat restriction, and limitation to a narrow geographic range centered on the corn-belt, listing of this species in Minnesota may be warranted.

Habitat	Occurrences	% Frequency	# Individuals	Average
Fen	1	5.88	31	1.82

23. *Helicodiscus parallelus* (Say, 1817). 400 individuals were uncovered from 48 sites and 13habitat types. Strong (p a 0.000003) preferences were noted in occurrence frequency among the four main habitat groups, with populations being most often found in upland forest (44% of sites) and upland grassland (29%) sites. It was least encountered in lowland grasslands (3%). It was most often found in Paper Birch (100% of sites), Maple-Basswood and Red Pine both 75%) forest habitats. The largest populations were located in Maple-Basswood forest (10.5 individuals/sample), Black Ash wetland (8.92), and Sand prairie (6). This species was much more prevalent in the southern half of the region. As such, strong ($p < 0.0000005$) variation was noted in occurrence frequency among physiographic regions, being highest in the Pine Moraines (53% of sites) and Leaf Hills (47%), and lowest in the Agassiz lowlands (5%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Paper Birch Forest	2	100.00	8	4.00
Maple-Basswood Forest	6	75.00	84	10.50
Red Pine Forest	3	75.00	9	2.25
Sand Prairie	1	50.00	12	6.00

Oak Forest	7	43.75	33	2.06
Mesic Prairie	3	42.86	5	0.71
Black Ash Wetland	5	41.67	107	8.92
Aspen Forest	13	35.14	94	2.54
Black Spruce Wetland	1	33.33	11	3.67
Jack Pine Forest	1	25.00	1	0.25
White Cedar Wetland	1	16.67	28	4.67
Fen	1	5.88	1	0.06
Tamarack Wetland	1	3.85	7	0.27

24. *Nesovitrea binneyana* (Morse, 1864). 5773 individuals from 99 stations and 16 habitat types. This species shows strong occurrence frequency preferences ($p < 0.0000005$) for upland forests (85% of sites), followed by lowland forests (52%), upland grasslands (14%) and lowland grasslands (6%). It was most frequently encountered in Oak, Maple-Basswood, Balsam-White Spruce, Paper Birch, Jack Pine, Red Pine, White Cedar forests (all 100%), Aspen forest (78.38%), and Black Ash wetlands (75%). The largest populations were observed in Aspen Forest (83.49 individuals/sample), Jack Pine (77.75), Oak (67.75), and Paper Birch (49) forests. While often found co-occurring with *Nesovitrea electrina,* it solely occurs in most pine dominated forests. Although found in all counties, significant ($p < 0.0000005$) variation in occurrence frequency was noted between the main physiographic regions, being most often found in wooded Aspen Parkland, Leaf Hills, Pine Moraines, and Agassiz Lowlands (53-80% of sites), and least encountered in the Red River Valley (16%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Oak Forest	16	100.00	1084	67.75
Maple-Basswood Forest	8	100.00	291	36.38
Balsam-White Spruce Forest	2	100.00	67	33.50
Paper Birch Forest	2	100.00	98	49.00
Jack Pine Forest	4	100.00	311	77.75
Red Pine Forest	4	100.00	152	38.00
White Cedar Wetland	6	100.00	131	21.83
Aspen Forest	29	78.38	3089	83.49
Black Ash Wetland	9	75.00	275	22.92
Black Spruce Wetland	2	66.67	18	6.00
Floodplain Forest	1	50.00	3	1.50
Sand Prairie	1	50.00	33	16.50
Tamarack Wetland	9	34.62	166	6.38
Sedge Meadow	1	33.33	4	1.33
Xeric Prairie	1	25.00	46	11.50
Wet Prairie	1	9.09	5	0.45

25. *Nesovitrea electrina* (Gould, 1841). 8388 individuals were observed at 153 sites and 19 habitat types. Populations tended ($p=0.002928$) to favor lowland (91-96% of sites) as opposed

to upland (71-76%) habitats. Populations were most frequently encountered in Balsam-White Spruce, Paper Birch, Floodplain, Tamarack, Black Spruce forests, Shrub Carr, Mesic Prairie, Sedge Meadow, Fen (all 100%), Black Ash wetland (91.67%), Aspen forest (89.19%), White Cedar wetland (83.33%), Wet Prairie (81.82%), Maple-Basswood forest and Calcareous Meadow (both 75%). The largest populations were found in Shrub Carr (130.67), Fen (130.59), Black Ash wetland (110.5), Sedge Meadow (99.67), and Calcareous Meadow (80.5) habitats. Populations occurred in all counties, and exhibited no significant variation between physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Balsam-White Spruce Forest	2	100.00	20	10.00
Paper Birch Forest	2	100.00	9	4.50
Floodplain Forest	2	100.00	77	38.50
Tamarack Wetland	26	100.00	1332	51.23
Black Spruce Wetland	3	100.00	126	42.00
Shrub Carr	3	100.00	392	130.67
Mesic Prairie	7	100.00	172	24.57
Sedge Meadow	3	100.00	299	99.67
Fen	17	100.00	2220	130.59
Black Ash Wetland	11	91.67	1326	110.50
Aspen Forest	33	89.19	1067	28.84
White Cedar Wetland	5	83.33	116	19.33
Wet Prairie	9	81.82	407	37.00
Maple-Basswood Forest	6	75.00	55	6.88
Calcareous Meadow	3	75.00	322	80.50
Oak Forest	11	68.75	225	14.06
Red Pine Forest	2	50.00	154	38.50
Xeric Prairie	2	50.00	53	13.25
Jack Pine Forest	1	25.00	16	4.00

26. *Oxyloma retusa* (I. Lea, 1834). 1404 individuals were located from 31 sites and 7 habitat types. Populations strongly ($p < 0.0000005$) favored lowland grassland habitats (occurring on 66% of sites) as opposed to the remaining habitat groups (1-14%). Populations were most frequently encountered in Fen (88.24% of sites), Shrub Carr (66.67%), and Wet Prairie (63.64%) habitats. The largest populations were found in Sedge Meadow (58.67 individuals/sample) and Fen (51.18) habitats. Populations were generally restricted to the southern 2.3 of the region. Populations tended ($p=0.001243$) to be more frequent in the Red River Valley (39% of sites), Aspen Parkland (18%), and Pine Moraines (12%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Fen	15	88.24	870	51.18
Shrub Carr	2	66.67	37	12.33

Wet Prairie	7	63:64	294	26.73
Sedge Meadow	1	33.33	176	58.67
Mesic Prairie	2	28.57	7	1.00
Black Ash Wetland	1	8.33	13	1.08
Tamarack Wetland	2	7.69	7	0.27

27. *Punctum minutissimum* (I.Lea, 1841). 10800 individuals of this species were recovered from 130 sites and 19 habitat types. It demonstrated a significant (p=0.000107) variation in occurrence frequency, being most often encountered in forest and upland grassland habitats (67-86%), and least in lowland grasslands (46%). It was most often observed in MapleBasswood, Balsam-White Spruce, Jack Pine, Red Pine, White Cedar forest (all 100%), Aspen Forest (89.19%), Mesic Prairie (85.71%), Black Ash Wetland (83.33), and Calcareous Meadow (75%). The largest populations were noted in Maple-Basswood forest (201.63 individuals/site), Black Ash wetland (160.58), Wet Prairie (99.82), Sedge Meadow (95), and Aspen forest (88.41). It was found in all counties, and demonstrated no significant variation in occurrence frequency among physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Maple-Basswood Forest	8	100.00	1613	201.63
Balsam-White Spruce Forest	2	100.00	31	15.50
Jack Pine Forest	4	100.00	188	47.00
Red Pine Forest	4	100.00	129	32.25
White Cedar Wetland	6	100.00	230	38.33
Aspen Forest	33	89.19	3271	88.41
Mesic Prairie	6	85.71	337	48.14
Black Ash Wetland	10	83.33	1927	160.58
Calcareous Meadow	3	75.00	128	32.00
Tamarack Wetland	17	65.38	889	34.19
Wet Prairie	7	63.64	1098	99.82
Oak Forest	10	62.50	323	20.19
Paper Birch Forest	1	50.00	12	6.00
Xeric Prairie	2	50.00	63	15.75
Sand Prairie	1	50.00	52	26.00
Black Spruce Wetland	1	33.33	24	8.00
Shrub Carr	1	33.33	66	22.00
Sedge Meadow	1	33.33	285	95.00
Fen	5	29.41	134	7.88

28. *Punctum* n.sp. First reported by Frest (1990) from Iowa fens, this taxon differs from Punctum minutissiumum and Punctum vitreum by having wider, more inflated whorls, a narrow umbilicus (< 20% shell diameter), and rusty-red color. It also can achieve larger maximum size ((> 1.2x0.75 mm), especially in fens. Because of the presence of intermediate individuals, additional morphometric and genetic analyses will be necessary to verify the

status of this taxon. 2190 individuals were located at 35 and 8 habitat types. Although limited in Iowa and Wisconsin to fen habitats, in northwestern Minnesota, it occurs in a wider range of habitats, including lowland forest, shrub carrs wet prairie, and other wet habitats. This species demonstrates a strong ($p < 0.0000005$) affinity for lowland habitats (33-39% of sites), while being almost absent (0-1%) from upland sites. It was most frequently encountered in Sedge Meadow` (100% of sites), Fen (76.47%), and Black Spruce wetland (66.67%) habitats. The largest populations were noted from Fen (89.65 individuals/sample), Shrub Carr (85), and Sedge Meadow (57.33) sites. This taxon was essentially found across the entire region, although it was absent from the extreme southeast and west-central. However, no significant differences were noted in occurrence frequency among the physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Sedge Meadow	3	100.00	172	57.33
Fen	13	76.47	1524	89.65
Black Spruce Wetland	2	66.67	47	15.67
Tamarack Wetland	10	38.46	133	5.12
Black Ash Wetland	4	33.33	33	2.75
Shrub Carr	1	33.33	255	85.00
Wet Prairie	1	9.09	6	0.55
Aspen Forest	1	2.70	20	0.54

29. *Punctum vitreum* H.B. Baker, 1930. This species is distinguished from both other *Punctum* taxa by having every 4th or 5th rib being markedly taller than the intervening, ones (Pilsbry, 1948). However, identification is often made difficult because of the presence of intermediate individuals, and the erosion of larger ribs, making them almost indistinguishable from the smaller. This species appears to replace *Punctum minutussimum* south of 450 N., and is the predominant form present in southern Wisconsin and Iowa. 169 individuals from 6 sites and 4 habitat types were noted. These individuals possessed only slightly more prominent large ribs, and seem to represent the intermediate forms that often occur near the juncture of both species ranges. No significant variation in occurrence frequency were noted between major habitat groups. It was most frequently encountered in Shrub Carr (33.33% of sites), Oak Forest (18.75) and Mesic Prairie (14.29). Largest populations were noted from Oak Forest (8.38 individuals/sample) and Shrub Carr (6.33). Although no significant variation in occurrence frequency was noted between physiographic regions, it was limited to sites in the far south (Clay, Becker, Mahnomen counties).

Habitat	Occurrences	% Frequency	# Individuals	Average
Shrub Carr	1	33.33	19	6.33
Oak Forest	3	18.75	134	8.38
Mesic Prairie	1	14.29	12	1.71
Fen	1	5.88	4	0.24

30. *Pupilla muscorum* (Linné, 1758). This species was found twice in the region through field sieving. Thus, no quantitative assessment of population size can be made. It has not, previously been reported from Minnesota. Both populations (on Lake Bemidji and Lake Itasca) were found on dry (sometimes heavily disturbed) lakeshore banks adjacent to state park boat ramps. It was unsuccessfully searched for at a number of other lakeshores in the region, and is thus likely not common. It is not clear if these represent native populations that are limited to dry lakeshore banks preferred for lakeshore access, or whether this species is nonnative and being transported to such sites by recreational activities. If further surveys . document its present rarity, state listing is probably warranted, especially to help better focus further development of boat ramp access in these areas.

31. *Striatura exigua* (Stimpson, 1847). 899 individuals were located from 31 sites and 11 habitat types. It demonstrated a strong ($p=0.000642$) preference in occurrence frequency to forest (especially lowland) sites (16-33%) as opposed to grasslands (0-3%). It was most frequently encountered in Black Spruce wetland (66.67% of sites), Balsam-White Spruce, Paper Birch, and Red Pine forest sites (all 50%). The largest populations were found in Black Spruce wetland (24 individuals/sample), Paper Birch forest (19), Red Pine forest (17.5), and White Cedar wetland (14.33). This species is limited to northern forest areas in the east of the study region. This variation in occurrence frequency was strong ($p < 0.0000005$), being most often located in the Leaf Hills and Pine Moraines (33-39%), but being absent from the Red River Valley and Aspen Parkland.

Habitat	Occurrences	% Frequency	# Individuals	Average
Black Spruce Wetland	2	66.67	72	24.00
Balsam-White Spruce Forest	1	50.00	9	4.50
Paper Birch Forest	1	50.00	38	19.00
Red Pine Forest	2	50.00	70	17.50
Black Ash Wetland	5	41.67	99	8.25
Maple-Basswood Forest	3	37.50	44	5.50
White Cedar Wetland	2	33.33	86	14.33
Sedge Meadow	1	33.33	3	1.00
Tamarack Wetland	8	30.77	247	9.50
Oak Forest	3	18.75	46	2.88
Aspen Forest	3	8.11	185	5.00

32. *Striatura milium* (Morse, 1859). 7527 individuals were collected at 117 sites and 16 habitat types. Like the previous species, it showed a strong ($p < 0.0000005$) occurrence preference to forested sites (83-86%) as opposed to grasslands (7-11%). It was most frequently encountered in Oak, Maple-Basswood, Balsam-White Spruce, Paper Birch, Jack Pine, and Red Pine forests, White Cedar and Black Spruce wetlands (all 100%), Tamarack wetland (92.31%), Aspen forest (77.76%), and Black Ash wetlands (75%). The largest populations were seen in Jack Pine forest (132.75-individuals/sample), Sedge Meadow (100), Red Pine (96.25) and Aspen (78.38) forest. While found in all counties, it became increasingly less frequent towards the southwest. Strong ($p < 0.0000005$) variation in occurrence frequency was noted between physiographic regions, being most frequent in the Agassiz Lowlands, Pine Moraines, and Leaf Hills (82-93%), and least in the Red River Valley (11%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Oak Forest	16	100.00	836	52.25
Maple-Basswood Forest	8	100.00	225	28.13
Balsam-White Spruce Forest	2	100.00	104	52.00
Paper Birch Forest	2	100.00	50	25.00
Jack Pine Forest	4	100.00	531	132.75
Red Pine Forest	4	100.00	385	96.25
White Cedar Wetland	6	100.00	334	55.67
Black Spruce Wetland	3	100.00	129	43.00
Tamarack Wetland	24	92.31	860	33.08
Aspen Forest	29	78.38	2877	77.76
Black Ash Wetland	9	75.00	835	69.58
Floodplain Forest	1	50.00	21	10.50
Sand Prairie	1	50.00	35	17.50
Sedge Meadow	1	33.33	300	100.00
Fen	2	11.76	2	0.12
Wet Prairie	1	9.09	3	0.27

33. *Strobilops afnis* Pilsbry, 1893. 527 individuals were collected from *7* sites and *4* habitat types. These populations represent the northwestern range limit for this species, and are disjunct 200 miles from the nearest previously known sites near the Twin Cities. Populations tended (p=0.012248) to be limited to lowland habitats (6-11% of sites), and were absent from upland sites. Populations were most frequently encountered in Black Spruce wetland, Shrub Carr (both 33% of sites), and Fen (23.53%) sites. The largest populations were found in Fen (28.82 individuals/sample) and Shrub Carr (10.00). Although no significant trends on occurrence frequency were noted between physiographic regions, populations were limited to the prairie-forest border in the southern half of the study region. As this species is one of the most characteristic and common taxa of fens in Iowa and southern Wisconsin, it likely occurs on most Minnesota fens sites to the south and east of this area. As such, even though rare in northwestern Minnesota, it likely does not warrant legal protection.

Habitat	Occurrences	% Frequency	# Individuals	Average
Black Spruce Wetland	1	33.33	1	0.33
Shrub Carr	1	33.33	30	10.00
Fen	4	23.53	490	28.82
Tamarack Wetland	1	3.85	6	0.23

34. *Strobilops labyrintbica* (Say, 1817). 9778 individuals were located from 110 sites and *18* habitat types. It demonstrated strong ($p < 0.0000005$) variation in occurrence frequency between the major habitat groups, being most common in upland forests ((81% of sites), followed by lowland forests (65%), lowland grasslands (29%), and upland grasslands (7%). It was most frequently encountered in Maple-Basswood, Balsam-White Spruce, Paper Birch, Jack Pine, Red Pine, and White Cedar forests (all 100%), Oak (87.5%), Aspen forest (75.68%), and Black Ash wetlands (75%). The largest populations were observed in Sedge Meadow (197.67 individuals/sample), Aspen forest (102.59), Black Ash wetland (99.42), Shrub Carr (94.33), Jack Pine (91), Oak (81.25) and Paper Birch (80.5) forests. Although found in all counties, significant ($p < 0.0000005$) variation was observed in occurrence frequency between physiographic regions, being. most common in the Leaf Hills and Pine Moraines (78-87%), and least in the Reel River Valley (21%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Maple-Basswood Forest	8	100.00	365	45.63
Balsam-White Spruce Forest	2	100.00	53	26.50
Paper Birch Forest	2	100.00	161	80.50
Jack Pine Forest	4	100.00	364	91.00
Red Pine Forest	4	100.00	182	45.50
White Cedar Wetland	6	100.00	278	46.33
Oak Forest	14	87.50	1300	81.25
Aspen Forest	28	75.68	3796	102.59
Black Ash Wetland	9	75.00	1193	99.42
Black Spruce Wetland	2	66.67	67	22.33
Tamarack Wetland	15	57.69	845	32.50
Floodplain Forest	1	50.00	4	2.00
Fen	7	41.18	241	14.18
Shrub Carr	1	33.33	283	94.33
Sedge Meadow	1	33.33	593	197.67
Xeric Prairie	1	25.00	39	9.75
Calcareous Meadow	1	25.00	1	0.25
Wet Prairie	1	9.09	13	1.18

35. *Succinea ovalis* Say, 1817. 593 individuals were collected from 30 sites and 11 habitat types. Even though usually considered a wetland species, no significant variation in occurrence frequency was noted among the 4 major habitat groups. Fully 20% of upland forest sites were found to harbor populations. The habitats with the highest occurrence frequency were Floodplain Forest (100%), Sedge Meadow (66.67%), and Paper Birch forest (50%). The largest populations were encountered in Floodplain Forest (38.5 individuals/sample), Black Ash wetland (19.58), and Sedge Meadow (10). Populations were primarily restricted to the north and west, being absent from Clearwater, Hubbard, and Mahnomen counties. Significant ($p=0.000771$) variation in occurrence frequency was noted

between physiographic provinces, being highest in the Agassiz Lowlands Aspen Parkland (2633%), and lowest in the Leaf Hills and Pine Moraines (4-7%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Floodplain Forest	2	100.00	77	38.50
Sedge Meadow	2	66.67	30	10.00
Paper Birch Forest	1	50.00	3	1.50 .
Black Ash Wetland	4	33.33	235	19.58
Shrub Carr	1	33.33	22	7.33
Oak Forest	4	25.00	56	3.50
Aspen Forest	9	24.32	135	3.65
Maple-Basswood Forest		1	12.50	17
Fen	2	11.76	2	0.12
Wet Prairie ,	1	9.09	1	0.09
Tamarack Wetland	2	7.69	15	0.58

36. *Vallonia costata* (Müller, 1774). 578 individuals were located at 23 sites and 10 habitat types. Populations tended (p=0.02947) to be more frequent in upland (15-36%) and less in lowland (6-9%) habitats. It was most often encountered in Floodplain Forest (50% of sites), Mesic Prairie (42.86%), and Shrub Carr (33.33%). The largest populations were found in Calcareous Meadow (47.5 individuals/sample), Floodplain Forest (24), and Mesic Prairie (10.57). This species was often found in sites that had been subjected to some degree of anthropogenic disturbance. Although no significant variation in occurrence was noted between physiographic provinces, populations appeared to be more frequent in the southern half of the region. It was not located in Lake of the Woods and Pennington counties.

Habitat	Occurrences	% Frequency	# Individuals	Average
Floodplain Forest	1	50.00	48	24.00
Mesic Prairie	3	42.86	74	10.57
Shrub Carr	1	33.33	3	1.00
Maple-Basswood Forest	2	25.00	29	3.63
Xeric Prairie	1	25.00	1	0.25
Calcareous Meadow	1	25.00	190	47.50
Wet Prairie	2	18.18	89	8.09
Oak Forest	2	12.50	67	4.19
Black Ash Wetland	1	8.33	23	1.92
Aspen Forest	2	5.41	54	1.46

37. *Vallonia gracilicosta* Reinhardt, 1883. 8223 individuals were located at 86 sites and 16 habitat types. Populations tended (p=0.008322) to be more often located in upland (57-60%) vs. lowland (33-37%) sites. It was most frequently encountered in Mesic prairie (71.43% of sites), Oak forest (68.75%), Black Ash wetland (66.67%), Aspen forest (64.86%), Wet prairie

(63.64%), and Maple-Basswood forest (62.5%). The largest populations were found in Black Ash wetland (245.08 individuals/site), Aspen forest (90.97), and Mesic prairie (48.14). While found essentially throughout the region (absent only from Hubbard County), populations appeared to be more frequent toward the west. Occurrence frequency between physiographic provinces tended (p=0.001737) to exhibit this pattern, being highest in the Red River Valley, Aspen Parkland, and Leaf Hills (6066%), and lowest in the Agassiz Lowlands and Pine Moraines (31-33%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Mesic Prairie	5	71.43	337	48.14
Oak Forest	11	68.75	539	33.69
Black Ash Wetland	8	66.67	2941	245.08
Aspen Forest	24	64.86	3366	90.97
Wet Prairie	7	63.64	439	39.91
Maple-Basswood Forest	5	62.50	277	34.63
Balsam-White Spruce Forest	1	50.00	3	1.50
Floodplain Forest	1	50.00	74	37.00
White Cedar Wetland	3	50.00	21	3.50
Xeric Prairie	2	50.00	11	2.75
Sand Prairie	1	50.00	12	6.00
Shrub Carr	1	33.33	16	5.33
Sedge Meadow	1	33.33	34	11.33
Calcareous Meadow	1	25.00	23	5.75
Fen	4	23.53	29	1.71
Tamarack Wetland	4	15.38	101	3.88

38. *Vallonia parvula* Sterki, 1892. 66 individuals were collected from two sites, both representing xeric gravel prairies in the Red River Valley (Barnesville WMA in Clay County and Chicog Prairie in Polk County). These represent the northern range limit for this central and southern plains species, being disjunct up to 200 miles north of the next closest site in eastcentral South Dakota. Although rare in the region, this species does not merit state listing, as it is frequent in the bedrock glades of the southeast (50+ individuals/sample), and is known from most xeric prairie remnants across the northern tier of counties and the Loess Hills in Iowa. It is likely a characteristic xeric grassland taxa throughout the southern third of Minnesota.

Habitat	Occurrences	% Frequency	# Individuals	Average
Xeric Prairie	2	50.00	66	16.50

39. *Vallonia perspectiva* Sterki, 1892. 634 individuals were observed from 19 sites and 8 habitat types. Its occurrence frequency significantly (p=0.000155) varied among habitat group, being highest in upland grasslands (43% of sites) and upland forest (14%), and lowest in

lowland grasslands (3%) and forests (2%). Its was most frequently found in Mesic (57.14%) and Sand (50%) prairie. The largest populations were encountered in Maple-Basswood (25.38 individuals/sample) and Oak (7.19) forests, Wet (6.45) and Xeric (6.25) prairie. Populations were limited to the southwestern half of the region, being absent from Hubbard, Lake of the Woods, and Roseau counties. Significant (p - 0.000115) variation in occurrence frequency was noted between physiographic provinces, being highest in the Red River Valley (29%) and Leaf Hills (20%) and lowest in the Pine Moraines (4%) and Agassiz Lowlands (0%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Mesic Prairie	4	57.14	35	5.00
Sand Prairie	1	50.00	2	1.00
Shrub Carr	1	33.33	2	0.67
Oak Forest	4	25.00	115	7.19
Maple-Basswood Forest	2	25.00	203	25.38
Xeric Prairie	1	25.00	25	6.25
Wet Prairie	1	9.09	71	6.45
Aspen Forest	3	8.11	181	4.89

40. *Vallonia pulchella* (Müller, 1774). 2016 individuals were collected from 30 sites and 11 habitat types. Populations tended (p=006217) to more frequently occur in grassland (32-36%) vs. forest (10-11%) habitats. It was most often encountered in Shrub Carr (66.67% of sites), Mesic Prairie (57.14%), Floodplain Forest (50%), and Wet Prairie (45.45%) habitats. The largest populations were noted from Wet Prairie (81.33 individuals/sample), Calcareous Meadow (67.75), Floodplain Forest (29.5) and Mesic Prairie (28.43). This species appeared to be especially frequent in sites that had experienced anthropogenic disturbance. Populations appeared largely limited to the southern half of the region. Occurrence frequencies between physiographic region tended (p - 0.010705) to be lowest in the Agassiz Lowlands (3%) and highest in the Leaf Hills (20%) and Red River Valley (32%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Shrub Carr	2	66.67	2	0.67
Mesic Prairie	4	57.14	199	28.43
Floodplain Forest	1	50.00	59	29.50
Wet Prairie	5	45.45	952	86.55
Sedge Meadow	1	33.33	244	81.33
Calcareous Meadow	1	25.00	271	67.75
Fen	4	23.53	103	6.06
Oak Forest	3	18.75	40	2.50
Black Ash Wetland	1	8.33	28	2.33
Tamarack Wetland	1	3.85	13	0.50
Aspen Forest	1	2.70	105	2.84

41. *Vertigo arthuri* (von Martens, 1884). This was the most frequent upland *Vertigo* species encountered, with 1005 individuals being located from 73 sites and 12 habitat types. Occurrence frequency significantly ($p < 0.0000005$) between habitat groups, being highest in upland (63%) and lowland (35%) forests, and lowest in grassland sites (7-11%). It was most frequently encountered in Balsam-White Spruce forest (100% of sites), White Cedar wetland (83.33%), Aspen forest (75.68%), and Black Ash wetland (58.33). The largest populations were found in Aspen (14.14 individuals/sample), Balsam-White Spruce (11) and Jack Pine (9.25) forest. Populations occurred over the extent of the study region and were found in all counties. However, there was a trend ($p=0.006013$) for occurrence frequencies to be lowest in the Red River Valley province (16% of sites), while being higher elsewhere (40-53%). Prior to this study, *V arthuri* was known only from the type location in western North Dakota, and about 2 dozen sites in the Black Hills of South Dakota and Wyoming. The abundance of this species in northwestern Minnesota was thus unexpected. Observation of additional collections indicate that *V. arthuri* extends in the Aspen Parkland through Edmonton, Alberta, and may also occur in Alaska. Given its wide geographic range in the region, and frequency, this species probably does not warrant listing, although it does represent one of the few species essentially limited to the Aspen Parkland province. Care should thus be taken to ensure its survival at the southeastern limit of its range.

Habitat	Occurrences	% Frequency	# Individuals	Average
Balsam-White Spruce Forest	2	100.00	22	11.00
White Cedar Wetland	5	83.33	17	2.83
Aspen Forest	28	75.68	523	14.14
Black Ash Wetland	7	58.33	93	7.75
Maple-Basswood Forest	4	50.00	56	7.00
Jack Pine Forest	2	50.00	37	9.25
Red Pine Forest	2	50.00	4	1.00
Oak Forest	7	43.75	122	7.63
Sedge Meadow	1	33.33	24	8.00
Tamarack Wetland	6	23.08	71	2.73
Wet Prairie	2	18.18	34	3.09
Fen	1	5.88	2	0.12

42. *Vertigo bollesiana* (Morse, 1865). 5 individuals were observed from 4 sites and 3 habitat types, all restricted to southern Beltrami and Clearwater counties. It appears limited to rich forests of Oak, Maple-Basswood, or White Cedar. This species is primarily found in the northern Appalachians through the Great Lakes region. The nearest populations occur in the Gogebic Range of northwestern Wisconsin, and on algific slopes in southeastern Minnesota. It was not located in our earlier survey of northeastern Minnesota igneous outcrops. Consideration for state listing of this species may be warranted, especially as it appears limited in this region to old growth forest stands, and to algific slopes in the southeast.

Habitat	Occurrences	% Frequency	# Individuals	Average
White Cedar Wetland	1	16.67	1	0.17
Maple-Basswood Forest	1	12.50	1	0.13
Oak Forest	1	6.25	3	0.19

43. *Vertigo cristata* (Sterki, 1919). 227 individuals were observed at 21 sites and 7 habitat types. This species showed a significant (p=0.000354) preference for forest sites, occurring in 9% of upland and 27% of lowland sites, while being absent from all grassland sites. Its lower frequency in upland forests is almost certainly due to an under-representation of coniferdominated forests, as it was most frequently encountered in Jack Pine, Red Pine (both 75%), and Black Spruce wetland (66.67%). Of the seven habitats where it was located, only 1 was not dominated by conifers, and only a single individual was located from this site. The largest populations were also encountered in upland conifer forests of Red Pine (28.50 individuals/sample) and Jack Pine (10). Wetland populations supported on average 1-5 individuals/sample. These data strongly suggest this species to be the dominant *Vertigo* of upland conifer forests in the region. It was found only in the northeastern and southeastern margins of the study region. Strong (p-0.000091) variation in occurrence frequency was noted between physiographic regions, being absent from the Red River Valley and Aspen Parklands, uncommon in the Leaf Hills (13% of sites) where it was limited to conifer wetlands, and more frequent in the Pine Moraines (29%) and Agassiz Lowlands (44%). This was the most commonly encountered *Vertigo* in igneous cliffs of northeastern Minnesota. Combined with its affinity for conifer-dominated uplands (including Jack Pine savanna), it is likely that this species will be found across the northern third of Minnesota, and that it likely does not warrant listing.

Habitat	Occurrences	% Frequency	# Individuals	Average
Jack Pine Forest	3	75.00	40	10.00
Red Pine Forest	3	75.00	114	28.50
Black Spruce Wetland	2	66.67	10	3.33
Balsam-White Spruce Forest	1	50.00	10	5.00
White Cedar Wetland	3	50.00	25	4.17
Tamarack Wetland	8	30.77	27	1.04
Black Ash Wetland	1	8.33	1	0.08

44. *Vertigo elatior* Sterki, 1894. This was the most common Vertigo in the region, with 2865 individuals being collected from 76 sites and 11 habitat types. It demonstrated a very strong ($p < 0.0000005$) preference in occurrence frequency to lowland habitats (74-83%), while being almost absent from uplands (0-9%). All upland sites where it was found were forests (mainly Aspen) that had small wet areas contained within them. It was most frequently encountered in Tamarack wetland, Black Spruce wetland, Shrub Carr, Sedge Meadow, Calcareous Meadow (all 100% of sites), Fen (82.35%), and Black Ash wetland (75%). The largest populations were observed in Calcareous Meadow (202 individuals/sample), Fen (62.88), Sedge Meadow (49.33),

and Shrub Carr (44.33). Although it was located in every county in the region, it tended (p=0.003255) to be most frequent in the Aspen Parkland (55% of sites) and Agassiz Lowlands (59%) and lowest in the Red River Valley (24%) and Leaf Hills (20%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Tamarack Wetland	26	100.00	275	10.58
Black Spruce Wetland	3	100.00	54	18.00
Shrub Carr	3	100.00	133	44.33
Sedge Meadow	3	100.00	148	49.33
Calcareous Meadow	4	100.00	808	202.00
Fen	14	82.35	1069	62.88
Black Ash Wetland	9	75.00	114	9.50
Wet Prairie	5	45.45	215	19.55
White Cedar Wetland	2	33.33	28	4.67
Aspen Forest	6	16.22	20	0.54
Oak Forest	1	6.25	1	0.06

45. *Vertigo gouldi* (A. Binney, 1843). A single specimen was located from the old-growth Maple-Basswood forest at Bear Paw Point at Lake Itasca. This is the northwestern-most site known, being disjunct from a single station in on the west shore of Lake County, Minnesota, and the limestone cliffs of the Paleozoic Plateau in the southeast. White certainly the rarest species in the region, its commonness in the southeastern corner of the state precludes it being listed for protection.

Habitat	Occurrences	% Frequency	# Individuals	Average
Maple-Basswood Forest	1	12.50	1	0.13

46. *Vertigo milium* (Gould, 1840). 2414 individuals were located from 33 sites and 7 habitat types. This species showed a strong ($p < 0.0000005$) preference for grassland (36-69% of sites) as compared to forest (2-4%) sites. It was most frequently encountered in Wet Prairie (81.82%), Mesic Prairie (71.43%), and Fen (70.59%) habitats. The largest populations were observed in Calcareous Meadow (102.25 individuals/sample), Fen (68.59), Wet Prairie (54.64), and Mesic Prairie (31.86) sites. It was essentially limited to the western third of the study region, being absent from Beltrami, Hubbard, Lake of the Woods, and Roseau counties. A significant ($p < 0.0000005$) variation in occurrence frequency was noted between physiographic regions, with populations being most frequent in the Red River Valley and Aspen Parkland (26-53%), and lowest in the remaining regions (0-7%). These populations represent the known northwestern range limit for this species. Although disjunct over 300 miles from the nearest reported sites in northern Iowa, it surely occurs in similar habitats throughout most of the southwestern half of Minnesota.

Habitat	Occurrences	% Frequency	# Individuals	Average
Wet Prairie	9	81.82	601	54.64
Mesic Prairie	5	71.43	223	31.86
Fen	12	70.59	1166	68.59
Calcareous Meadow	2	50.00	409	102.25
Shrub Carr	1	33.33	1	0.33
Sedge Meadow	1	33.33	3	1.00
Aspen Forest	3	8.11	11	0.30

47. *Vertigo morsei* Sterki, 1894. 183 individuals were observed from 12 sites. This species was limited to lowland grassland areas ($p < 0.0000005$), with all but one of these sites representing fens. The other site (at Pankratz Prairie) was a wet prairie supporting calciphile vegetation such as Triglochin maritima and juncus balticus. This is the only site for this species observed in over 6 years of field research that was not a fen. Vertigo morsei was located on 64.71% of surveyed fens in the region, and almost 100% of appropriate sites in the southwestern third of the region. Nowhere else has this species been found so reliably; I have been able to find it previously on only 6 stations ranging from Iowa through New York. Frest (1990) only located this species on 2 out of 64 surveyed Iowa fen sites. While most populations were small (< 10 individuals/sample), 93 individuals were obtained at the ,Fourtown Fen, 20 from Wabun SE Fen, 19 from Felton 2, and 15 from Ogema W. The Fourtown site is particularly important, as individuals were not only common, but the site appeared to cover well over 1000 ha. If the observed density is consistent throughout this site, it undoubtedly represents the largest population for this species in the world. Even though a consistent component of the fen fauna in part of the study region, the rarity of this species elsewhere in North America, combined with its almost total restriction to high-quality fens, suggests that it should be afforded state protection, probably at the 'Threatened' level.

Habitat	Occurrences	% Frequency	# Individuals	Average
Fen	11	64.71	179	10.53
Wet Prairie	1	9.09	4	0.36

48. *Vertigo nylanderi* Sterki, 1909. 278 individuals were observed at 35 sites and 6 habitat types. Occurrence frequency was significantly ($p < 0.0000005$) greater in lowland forest sites (60%), although some populations also occurred in low grasslands (9% of sites). It was essentially absent from upland sites (0-1%). Populations were most frequently encountered in Black Spruce (100% of sites), Tamarack (76.92%), and Black Ash (58.33%) wetlands. Lowland grassland populations were limited to fens (18% of sites), where populations were typically found in leaf litter accumulations under stunted Tamarack shrubs. The largest populations were encountered in Tamarack (7.38 individuals/sample), Black Spruce (6.33), and Black Ash (3.08) wetlands. Populations were limited to the eastern half of the study region, being absent. from Clay, Kittson, Norman, Pennington, and Red Lake counties. However, populations were found from the extreme south (Frazee East) to the extreme north (Sprague Creek).

Strong ($p < 0.0000005$) variation was noted in occurrence frequency between physiographic regions, with populations being most frequently encountered in the Agassiz Lowlands (44% of sites) and Pine Moraines (29%). It was also rarely present in Aspen Parkland and the Leaf Hills (5-7%), but absent from the Red River Valley. This species was long known from only 5 pre-1950's collections. Outside of this region, I have only collected it from 18 stations across the Great Lakes region, and in none of these other regions does this species become a predictable component of the wooded wetland fauna. Thus, like the previous species, northwestern Minnesota must be considered the modal landscape for this very rare species. Because of its relative frequency, it is not clear that this species should be listed for protection.

Habitat	Occurrences	% Frequency	# Individuals	Average
Black Spruce Wetland	3	100.00	19	6.33
Tamarack Wetland	20	76.92	192	7.38
Black Ash Wetland	7	58.33	37	3.08
Fen	3	17.65	25	1.47
White Cedar Wetland	1	16.67	4	0.67
Aspen Forest	1	2.70	1	0.03

49. *Vertigo ovata* Say, 1822. 560 individuals were located from 30 sites and 10 habitats. Populations demonstrated a strong ($p=0.000002$) preference for lowland grasslands (43% of sites), through it was also a regular component of upland grassland (29%) and lowland forest (15%) sites. It was almost absent from upland forests (4%). It was most frequently encountered in Sedge Meadow (66.67% of sites), Wet Prairie (63.64%), Mesic Prairie (57.14), and Calcareous Meadow (50%) habitats. The largest populations were observed in Sedge Meadow (28.67 individuals/sample), Calcareous Meadow (20), and Wet Prairie (18.64) sites. This species was found essentially throughout the region, only being absent from Hubbard County, and no significant variation was noted between the physiographic provinces.

Habitat	Occurrences	% Frequency	# Individuals	Average
Sedge Meadow	2	66.67	86	28.67
Wet Prairie	7	63.64	205	18.64
Mesic Prairie	4	57.14	39	5.57
Calcareous Meadow	2	50.00	80	20.00
Shrub Carr	1	33.33	9	3.00
Fen	4	23.53	114	6.71
Black Ash Wetland	2	16.67	12	1.00
White Cedar Wetland		1	16.67	1
Tamarack Wetland	4	15.38	10	0.38
Aspen Forest	2	5.41	4	0.11

50. *Vertigo paradoxa* Sterki, 1900. This was one of the rarer species encountered, with only 53 individuals being observed from 7 sites and 4 habitat types. Populations were essentially

limited to lowland forest sites (p=0.022424). Populations were most frequently located in BalsamWhite Spruce forest and White Cedar wetland (both 50% of sites). The largest populations were limited to White Cedar wetland (7.83). Thus, this species appears essentially limited in the area to high quality, wet, and cold White Cedar swamp forests. It is found only in the extreme east of the study region in Beltrami, Clearwater, Hubbard, and Lake of the Woods counties. It is absent from the Red River Valley, Aspen Parkland, and Leaf Hills physiographic regions. It was found on only 20 igneous cliff sites in northeastern Minnesota, and while likely found between these two sample regions, these data suggest that it will be a rare component of only the highest quality White Cedar wetlands. As such, state listing at least at the Special Concern level seems warranted.

Habitat	Occurrences	% Frequency	# Individuals	Average
White Cedar Wetland	3	50.00	47	7.83
Balsam-White Spruce Forest	1	50.00	1	0.50
Black Ash Wetland	1	8.33	1	0.08
Tamarack Wetland	2	7.69	4	0.15

51. *Vertigo pygmaea* (Draparnaud, 1801). This species was added to the state fauna from two disturbed sites in Lake Itasca State Park: a lakeshore boatramp, and a xeric old field. As both of these sites were sampled via field sieving, quantitative data is not available, but population sizes appeared moderate to small. This taxon is one of the most tolerant in the North American fauna to anthropogenic disturbance, being commonly found to the east along road verges, house foundations, culverts, and abandoned quarries (Hubricht 1985). This species also is tolerant of human disturbance in western Eurasia. It seems possible that North American populations may represent exotic invaders that were carried to this continent by Euro-americans in animal forage. The Lake Itasca sites represent the most northwestern yet known on the continent, with the nearest being Hayden Prairie in northeastern Iowa, which itself is disjunct from a series of populations found around urban areas on the west side of Lake Michigan. Inventory of disturbed grassland sites throughout the state will undoubtedly uncover additional sites.

52. *Vitrina limpida* Gould, 1850. 813 individuals were located from 49 sites and 14 habitat types. It demonstrated a significant (p=0.000108) increase in occurrence frequency in upland forests (44% of sites) as compared to the other habitat groups (11-21%). It was most often encountered in Aspen (54.05% of sites), Oak (50%), Floodplain (50%) forest and Sand Prairie (50%). The largest populations were found in Floodplain (17 individuals/sample), Aspen (14.35), Oak (8.06) forest, Sand Prairie (6.5), Black Ash wetland (5.92), and Sedge Meadow (4.33). Although located in every county, its occurrence frequency did significantly (p=0.000248) between physiographic regions, being highest in Aspen Parkland 58% of sites), with it being 1/3 as frequent (16-22%) in the remaining regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Aspen Forest	20	54.05	531	14.35
Oak Forest	8	50.00	129	8.06
Floodplain Forest	1	50.00	34	17.00
Sand Prairie	1	50.00	13	6.50
Black Ash Wetland	5	41.67	71	5.92
Sedge Meadow	1	33.33	13	4.33
Maple-Basswood Forest	2	25.00	3	0.38
Jack Pine Forest	1	25.00	3	0.75
Xeric Prairie	1	25.00	3	0.75
Calcareous Meadow	1	25.00	1	0.25
Mesic Prairie	1	14.29	2	0.29
Wet Prairie	1	9.09	3	0.27
Fen	1	5.88	1	0.06
Tamarack Wetland	1	3.85	6	0.23

53. *Zonitoides arboreus* (Say, 1816). This was the most frequent species in the region, with 3233 individuals being observed from 159 sites (88% of total) and all 20 habitat types. Significant variation in occurrence frequency was observed between habitat groups, being highest in forests (90-99%), and lowest in upland grasslands ((57%). It was most frequently encountered in Oak, Maple-Basswood, Paper Birch, Aspen, Jack Pine, Red Pine, Floodplain forest, Black Ash, White Cedar, Black Spruce wetland, Shrub Carr (all 100% of sites), Tamarack wetland (80.77%), Fen (76.47%), and Calcareous Meadow (75%). The largest populations were observed in Maple-Basswood (44.25 individuals/sample), Red Pine (39.25), Oak (39) forest, Black Ash wetland (27.33), and Aspen forest (26.84). It was found in all counties, but tended (p - 0.033832) to be less frequent in the Red River Valley (74% of sites) as compared to the remaining physiographic regions (87-97%).

Habitat	Occurrences	% Frequency	# Individuals	Average
Oak Forest	16	100.00	624	39.00
Maple-Basswood Forest	8	100.00	354	44.25
Paper Birch Forest	2	100.00	15	7.50
Aspen Forest	37	100.00	993	26.84
Jack Pine Forest	4	100.00	47	11.75
Red Pine Forest	4	100.00	157	39.25
Floodplain Forest	2	100.00	24	12.00
Black Ash Wetland	12	100.00	328	27.33
White Cedar Wetland	6	100.00	44	7.33
Black Spruce Wetland	3	100.00	56	18.67
Shrub Carr	3	100.00	34	11.33
Tamarack Wetland	21	80.77	252	9.69
Fen	13	76.47	83	4.88

Calcareous Meadow	3	75.00	22	5.50
Mesic Prairie	5	71.43	35	5.00
Sedge Meadow	2	66.67	52	17.33
Wet Prairie	7	63.64	73	6.64
Balsam-White Spruce Forest	1	50.00	15	7.50
Xeric Prairie	2	50.00	5	1.25
Sand Prairie	1	50.00	20	10.00

54. *Zonitoides nitidus* (Müller, 1774). 174 individuals were located at 11 sites and 6 habitat types. No significant variation was noted in occurrence frequency between habitat groups. It was most frequently encountered in Shrub Carr (33.33% of sites), Black Ash wetland (25%), and Fen (11.76%) sites. The largest populations were observed in Shrub Carr (18 individuals/site) and Black Ash (7.42) wetlands. Populations were sporadically scattered throughout the region, being absent from Clay, Marshall, Norman, and Pennington counties. No significant variation was noted in occurrence frequency between the major physiographic regions.

Habitat	Occurrences	% Frequency	# Individuals	Average
Shrub Carr	1	33.33	54	18.00
Black Ash Wetland	3	25.00	89	7.42
Fen	2	11.76	25	1.47
Wet Prairie	1	9.09	1	0.09
Oak Forest	1	6.25	4	0.25
Tamarack Wetland	1	3.85	1	0.04

Habitat Associations.

1. Upland Forests

A. Oak Forest (16 sites).

These sites were scattered across the region, but particularly common on dry, sandy dune . ridges along the former Lake Agassiz shore, and in steep moraine landscapes. 35 taxa were encountered, with an average of 569 individuals being recovered per sample. The most frequent species were *Euconulus fulvus, Nesovitrea binneyana, Striatura milium, Zonitoides arboreus* (all 100% of sites), *Carychium exile, Discus catskillensis, Strobilops labyrintbica* (all 87.5%), *Cochlicopa lubricella, Gastrocopta pentodon, Nesovitrea electrina, Vallonia gracilicosta* (all 68.75%). *Columella simplex, Punctum minutissimum* (both 62.5%), *Gastrocopta contracta, Hawaiia minuscula* (Both 56.25%), and *Vitrina limpida* (50%). The most abundant species were *Strobilops labyrintbica* 81.25 individuals/sample), *Nesovitrea binneyana* (67.75), *Striatura milium* (52.25), *Discus catskillensis* (45.31), *Zonitoides arboreus* (39), *Carychium exile* (35.63), and *Vallonia gracilicosta* (33.69).

Species	Occurrences	% Frequency	# Individuals	Average
Nesovitrea binneyana	16	100.00	1084	67.75
Striatura milium	16	100.00	836	52.25
Zonitoides arboreus	16	100.00	624	39.00
Euconulusfulvus	16	100.00	383	23.94
Strobilops labyrintbica	14	87.50	1300	81.25
Discus catskillensis	14	87.50	725	45.31
Carychium exile	14	87.50	570	35.63
Vallonia gracilicosta	11	68.75	539	33.69
Gastrocopta pentodon	11	68.75	323	20.19
Nesovitrea electrina	11	68.75	225	14.06
Cochlicopa lubricella	11	68.75	132	8.25
Punctum minutissimum	10	62.50	323	20.19
Columella simplex	10	62.50	58	3.63
Gastrocopta contracta	9	56.25	80	5.00
Hawaiia minuscula	9	56.25	77	4.81
Vitrina limpida	8	50.00	129	8.06
Vertigo arthuri	7	43.75	122	7.63
Helicodiscus parallelus	7	43.75	33	2.06
Gastrocopta holzingeri	6	37.50	178	11.13
Gastrocopta tappaniana	6	37.50	38	2.38
Discus cronkhitei	5	31.25	22	1.38
Vallonia perspectiva	4	25.00	115	7.19
Cochlicopa lubrica	4	25.00	108	6.75
Succinea ovalis	4	25.00	56	3.50
Punctum vitreum	3	18.75	134	8.38
Striatura exigua	3	18.75	46	2.88
Vallonia pulchella	3	18.75	40	2.50
Deroceras laeve	3	18.75	5	0.31
Vallonia costata	2	12.50	67	4.19
Anguispira alternata	2	12.50	2	0.13
Carychium exiguum	1	6.25	7	0.44
Zonitoides nitidus	1	6.25	4	0.25
Vertigo bollesiana	1	6.25	3	0.19
Catinella avara	1	6.25	1	0.06
Vertigo elatior	1	6.25	1	0.06

B. Maple-Basswood Forest (8 sites).

Maple-basswood forests were found primarily in the southern half of the study region in the Leaf Hills and Pine Moraines physiographic regions. Most sites were characterized by hard, clay-rich soils supporting very thin leaf litter layers. However a few sites (often dominated by Basswood) were found to have loamy soils with very deep humus layers. Such sites (such as the old-growth forest at Bear Paw Point in Lake Itasca Sate Park) supported a very high

richness and abundance of snails. 32 taxa were encountered over all sites, with an average of 1045 individuals being observed per sample. The most frequently encountered species were *Carychium exile, Euconulus fulvus, Nesovitrea binneyana, Punctum minutissimum, Striatura milium, Strobilops labyrinthica, Zonitoides arboreus* (all 100% of sites), *Cochlicopa lubricella* (87.5%), *Columella simplex, Discus catskillensis, Gastrocopta contracta, Helicodiscus parallelus, Nesovitrea electrina* (all 75%), *Gastrocopta pentodon , Hawaiia minuscula, Vallonia gracilicosta* (all 62.5%), *Gastrocopta holzingeri* and *Vertigo arthuri* (both 50%). The most abundant species were *Punctum minutissimum* (201.63 individuals/sample), *Gastrocopta holzingeri* (136.5), *Carychium exile* (79.75), *Strobilops labyrinthica* (45.63), and *Zonitoides arboreus* (44.25).

Species	Occurrences	% Frequency	# Individuals	Average
Punctum minutissimum	8	100.00	1613	201.63
Carychium exile	8	100.00	638	79.75
Strobilops labyrinthica	8	100.00	365	45.63
Zonitoides arboreus	8	100.00	354	44.25
Nesovitrea binneyana	8	100.00	291	36.38
Striatura milium	8	100.00	225	28.13
Euconulus fulvus	8	100.00	212	26.50
Cochlicopa lubricella	7	87.50	263	32.88 .
Discus catskillensis	6	75.00	245	30.63
Gastrocopta contracta	6	75.00	97	12.13
Helicodiscus parallelus	6	75.00	84	10.50
Nesovitrea electrina	6	75.00	55	6.88
Columella simplex	6	75.00	42	5.25
Hawaiia minuscula	5	62.50	305	38.13
Vallonia gracilicosta	5	62.50	277	34.63
Gastrocopta pentodon	5	62.50	158	19.75
Gastrocopta holzingeri	4	50.00	1092	136.50
Vertigo arthuri	4	50.00	56	7.00
Striatura exigua	3	37.50	44	5.50
Cochlicopa lubrica	2	25.00	256	32.00
Vallonia perspectiva	2	25.00	203	25.38
Vallonia costata	2	25.00	29	3.63
Anguispira alternata	2	25.00	15	1.88
Discus cronkhitei	2	25.00	4	0.50
Vitrina limpida	2	25.00	3	0.38
Carychium exiguum	1	12.50	27	3.38
Succinea ovalis	1	12.50	17	2.13
Gastrocopta tappaniana	1	12.50	11	1.38
Catinella avara	1	12.50	6	0.75
Deroceras laeve	1	12.50	1	0.13
Vertigo bollesiana	1	12.50	1	0.13
Vertigo gouldi	1	12.50	1	0.13

C Balsam-White Spruce Forest (2 sites).

These sites represent upland forests which were dominated by either Balsam Fir or White Spruce. 22 species were found in these sites with an average of 286 individuals being observed per sample. Species found on both sites were *Carychium exile, Cochlicopa lubricella, Discus catskillensis, Euconulus fulvus, Nesovitrea binneyana, Nesovitrea electrina, Punctum minutissimum, Striatura milium, Strobilops labyrintbica,* and *Vertigo arthuri.* The most abundant species were *Striatura milium* (52 individuals/site), *Carychium exile* (45.5), *Discus catskillensis* (35.5), *Nesovitrea binneyana* (33.5), and *Strobilops labyrintbica* (26.5).

Species	Occurrences	% Frequency	# Individuals	Average
Striatura milium	2	100.00	104	52.00
Carychium exile	2	100.00	91	45.50
Discus catskillensis	2	100.00	71	35.50
Nesovitrea binneyana	2	100.00	67	33.50
Strobilops labyrintbica	2	100.00	53	26.50
Punctum minutissimum	2	100.00	31	15.50
Vertigo arthuri	2	100.00	22	11.00
Nesovitrea electrina	2	100.00	20	10.00
Euconulus fulvus	2	100.00	13	6.50
Cochlicopa lubricella	2	100.00	3	1.50
Zonitoides arboreus	1	50.00	15	7.50
Vertigo cristata	1	50.00	10	5.00
Striatura exigua	1	50.00	9	4.50
Gastrocopta tappaniana	1	50.00	7	3.50
Gastrocopta holzingeri	1	50.00	5	2.50
Vallonia gracilicosta	1	50.00	3	1.50
Anguispira alternata	1	50.00	2	1.00
Columella simplex	1	50.00	2	1.00
Gastrocopta contracta	1	50.00	2	1.00
Deroceras laeve	1	50.00	1	0.50
Discus cronkhitei	1	50.00	1	0.50
Vertigo paradoxa	1	50.00	1	0.50

D. Paper Birch Forest (2 sites).

These sites typically had thick leaf litter layers over sandy or loamy soil. 15 species were found, with an average of 235 individuals being recorded per sample. Species observed in both sites include *Cochlicopa lubricella, Columella simplex, Discus catskillensis, Euconulus fulvus, Helicodiscus parallelus, Nesovitrea binneyana, Nesovitrea electrina, Striatura milium, Strobilops labyrintbica,* and *Zonitoides arboreus.* Species with the largest populations were *Strobilops labyrintbica* (80.50 individuals/site), *Nesovitrea binneyana* (49), *Striatura milium* (25), *Striatura exigua* (19), *Discus catskillensis (14),* and *Carychium exile* (11.5).

Species	Occurrences	% Frequency	# Individuals	Average
Strobilops labyrintbica	2	100.00	161	80.50
Nesovitrea binneyana	2	100.00	98	49.00
Striatura milium	2	100.00	50	25.00
Discus catskillensis	2	100.00	28	14.00
Zonitoides arboreus	2	100.00	15	7.50
Cochlicopa lubricella	2	100.00	10	5.00
Nesovitrea electrina	2	100.00	9	4.50
Euconulus fulvus	2	100.00	8	4.00
Helicodiscus parallelus	2	100.00	8	4.00
Columella simplex	2	100.00	5	2.50
Striatura exigua	1	50.00	38	19.00
Carychium exile	1	50.00	23	11.50
Punctum minutissimum	1	50.00	12	6.00
Succinea ovalis	1	50.00	3	1.50
Gastrocopta pentodon	1	50.00	1	0.50

E. Aspen Forest (37 sites).

These sites were found in a wide variety of settings. In the Aspen Parkland and Red River Valley regions, these represent the climax forest and are often associated with thick litter layers. In this region, sites could occur from dry-xeric ridges to wet-mesic flats with some vernal pools. Elsewhere, aspen forests generally represent an early successional forest transitional to Maple-Basswood, Oak, or upland Conifers. These areas also could occur from dry to wet-mesic soils, but generally did not possess deep leaf litter layers. 37 species were recorded from these sites, with an average of 878 individuals/sample. The most frequently encountered species were *Zonitoides arboreus* (100% of sites), *Euconulus fulvus* (97.3%), *Nesovitrea electrina, Punctum minutissimum* (both 89.19%), *Discus catskillensis, Nesovitrea binneyana, Striatura milium* (all 78.38%), *Strobilops labyrintbica, Vertigo arthuri* (both 75.68%), *Cochlicopa lubricella* (72.97%), *Vallonia gracilicosta* (64.86%), *Carychium exile* (59.46%), *Gastrocopta tappaniana* (56.76%), *Columella simplex,* and *Vitrina limpida* (both 54.05%). The species with the largest average populations were *Strobilops labyrintbica* (102.59 individuals/site), *Vallonia gracilicosta* (90.97), *Punctum minutissimum* (88.41), *Nesovitrea binneyana* (83.49), *Striatura milium* (77.76) and *Carychium exile* (67.7).

Species	Occurrences	% Frequency	# Individuals	Average
Zonitoides arboreus	37	100.00	993	26.84
Euconulus fulvus	36	97.30	1076	29.08
Punctum minutissimum	33	89.19	3271	88.41
Nesovitrea electrina	33	89.19	1067	28.84
Nesovitrea binneyana	29	78.38	3089	83.49
Striatura milium	29	78.38	2877	77.76
Discus catskillensis	29	78.38	1181	31.92

Strobilops labyrinthica	28	75.68	3796	102.59
Vertigo arthuri	28	75.68	523	14.14
Cochlicopa lubricella	27	72.97	949	25.65
Vallonia gracilicosta	24	64.86	3366	90.97
Carychium exile	22	59.46	2505	67.70
Gastrocopta tappaniana	21	56.76	766	20.70
Vitrina limpida	20	54.05	531	14.35
Columella simplex	20	54.05.	245	6.62
Gastrocopta pentodon	18	48.65	1091	29.49
Hawaiia minuscula	17	45.95	215	5.81
Discus cronkhitei	16	43.24	107	2.89
Gastrocopta holzingeri	15	40.54	797	21.54
Helicodiscus parallelus	13	35.14	94	2.54
Gastrocopta contracta	10	27.03	236	6.38
Succinea ovalis	9	24.32	135	3.65
Carychium exiguum	8	21.62	471	12.73
Euconulus alderi	6	16.22	130	3.51
Vertigo elatior	6	16.22	20	0.54
Catinella avara	5	13.51	48	1.30
Deroceras laeve	5	13.51	30	0.81
Striatura exigua	3	8.11	185	5.00
Vallonia perspectiva	3	8.11	181	4.89
Vertigo milium	3	8.11	11	0.30
Cochlicopa lubrica	2	5.41	92	2.49
Vallonia costata	2	5.41	54	1.46
Vertigo ovata	2	5.41	4	0.11
Vallonia pulchella	1	2.70	105	2.84
Punctum n.sp.	1	2.70	20	0.54
Anguispira alternata	1	2.70	1	0.03
Vertigo nylanderi	1	*2.70*	*1*	*0.03*

F. Jack Pine Forest (4 sites).

These sites are limited in the region to sandy soils in the Agassiz Lowlands and Pine Moraines physiographic provinces. Moisture levels ranged from mesic to xeric, with the driest sites developing a savanna-like architecture. In such sites, snails were primarily limited to deep leaf litter accumulations under deciduous shrubs, primarily hazel. *17* species were observed on these sites, with an average of *495* individuals occurring per sample. The most frequently encountered species were *Euconulus fulvus, Nesovitrea binneyana, Punctum minutissimum, Striatura milium, Strobilops labyrinthica, Zonitoides arboreus* (all 100% of sites), *Columella simplex, Discus catskillensis,* and *Vertigo cristata* (all 75%). The species with the largest average population sizes were *Striatura milium* (132.75 individuals/sample), *Strobilops labyrintbica* (91), *Nesovitrea binneyana* (77.75), *Discus catskillensis* (62), and *Punctum minutissimum* (47).

Species	Occurrences	% Frequency	# Individuals	Average
Striatura milium	4	100.00	531	132.75
Strobilops labyrintbica		4	100.00	364 91.00
Nesovitrea binneyana	4	100.00	311	77.75
Punctum minutissimum		4	100.00	188 47.00
Euconulus fulvus	4	100.00	59	14.75
Zonitoides arboreus	4	100.00	47	11.75
Discus catskillensis	3	75.00	248	62.00
Vertigo cristata	3	75.00	40	10.00
Columella simplex	3	75.00	9	2.25
Vertigo arthuri	2	50.00	37	9.25
Nesovitrea electrina	1	25.00	16	4.00
Cochlicopa lubricella	1	25.00	10	2.50
Carychium exile	1	25.00	4	1.00
Vitrina limpida	1	25.00	3	0.75
Discus cronkhitei	1	25.00	1	0.25
Gastrocopta tappaniana	1	25.00	1	0.25
Helicodiscus parallelus	1	25.00	1	0.25

G. Red Pine Forest (4 sites).

These sites were also limited to the Agassiz Lowlands and Pine Moraines. However, they occurred on loamy as well as sandy soils, and leaf litter was usually deep throughout. White Pine was often also present, as were Oaks and other deciduous trees. 18 species were observed, with an average of 488 individuals being observed per sample. The most frequently encountered species were *Columella simplex, Discus catskillensis, Euconulus fulvus, Nesovitrea binneyana, Punctum minutissimum, Striatura milium, Strobilops labyrintbica, Zonitoides arboreus* (all 100%), *Carychium. exile, Helicodiscus parallelus,* and *Vertigo cristata* (all 75%). The species with the largest average population sizes were *Striatura milium* (96.25 individuals/site), *Discus catskillensis* (49), *Strobilops labyrintbica* (45.5), *Zonitoides arboreus* (39.25), *Nesovitrea electrina* (38.50), and *Nesovitrea binneyana* (38).

Species	Occurrences	% Frequency	# Individuals	Average
Striatura milium	4	100.00	385	96.25
Discus catskillensis	4	100.00	196	49.00
Strobilops labyrintbica	4	100.00	182	45.50
Zonitoides arboreus	4	100.00	157	39.25
Nesovitrea binneyana	4	100.00	152	38.00
Punctum minutissimum	4	100.00	129	32.25
Euconulus fulvus	4	100.00	66	16.50
Columella simplex	4	100.00	34	8.50
Vertigo cristata	3	75.00	114	28.50
Carychium exile	3	75.00	102	25.50

Helicodiscus parallelus	3	75.00	9	2.25
Nesovitrea electrina	2	50.00	154	38.50
Striatura exigua	2	50.00	70	17.50
Vertigo arthuri	2	50.00	4	1.00
Cochlicopa lubricella	1	25.00	12	3.00
Gastrocopta pentagon	1	25.00	5	1.25
Carychium exiguum	1	25.00	1	0.25
Gastrocopta tappaniana	1	25.00	1	0.25

F. Lakeshore Forest (7 sites).

All Lakeshore sites were sampled via field sieving, and as such the species richness and abundance figures derived for them cannot be compared to sites that were litter sampled. The sites sampled were limited to the southeast. *Pupilla muscorum,* new to the state fauna, was limited to these sites.

2. Lowland Forests

A. Floodplain Forest (2 sites).

Owing to the scouring of the leaf litter during floods, and their relatively hard, clay soils, only two sites were sampled. 21 species and 439 individuals/sample were recorded. The species

found on both sites were *Carychium exile, Cochlicopa lubrica, Columella simplex, Discus cronkhitei, Euconulus fulvus, Hawaiia minuscula, Nesovitrea electrina, Succinea ovalis,* and *Zonitoides arboreus.* The most abundant species were Discus *catskillensis* (41.50 individuals/site), *Carychium exile* (41), *Nesovitrea electrina, Succinea ovalis* (both 38.5), *Vallonia gracilicosta* (37), *Vallonia pulchella* (29.5) and *Vallonia costata* (24).

Cochlicopa lubrica	2	100.00	83	41.50
Carychium exile	2	100.00	82	41.00
Nesovitrea electron	2	100.00	77	38.50
Succinea ovalis	2	100.00	77	38.50
Zonitoides arboreus	2	100.00	24	12.00
Hawaiia minuscula	2	100.00	20	10.00
Discus cronkhitei	2	100.00	18	9.00
Euconulus fulvus	2	100.00	9	4.50
Columella simplex	2	100.00	4	2.00
Discus catskillensis	1	50.00	84	42.00
Vallonia gracilicosta	1	50.00	74	37.00
Vallonia pulchella	1	50.00	59	29.50
Vallonia costata	1	50.00	48	24.00
Vitrina limpida	1	50.00	34	17.00
Striatura milium	1	50.00	21	10.50
Anguispira alternata	1	50.00	11	5.50
Cochlicopa lubricella	1	50.00	10	5.00

Strobilops labyrintbica		1	50.00	4
Nesovitrea binneyana	1	50.00	3	1.50
Gastrocopta tappaniana		1	50.00	2
Deroceras laeve	1	50.00	1	0.50

B. Black Ash Swamp Forest (12 sites).

These sites are limited to the eastern 2/3 of the study region, being absent from the Red River Valley physiographic province. 41 species (76% of the regional total) and 1618 individuals/site were recorded. The single most abundant concentration of land snails per sample (5492 at Strathcona SW) was recorded from this habitat type, with other sites harboring impressive numbers as well (e.g. Hal Swamp WMA with 4232 individuals/sample). The most frequently encountered taxa were *Zonitoides arboreus* (100% of sites), *Nesovitrea electrina* (91.67%), *Carychium exiguum, Carychium exile, Cochlicopa lubricella, Gastrocopta tappaniana, Punctum minutissimum* (all 83.33%), *Euconulus fulvus, Nesovitrea binneyana, Striatura milium, Strobilops labyrintbica, Vertigo elatior* (all 75%), *Hawaiia minuscula, Vallonia gracilicosta* (both 66.67%), *Columella simplex, Vertigo arthuri,* and *Vertigo nylanderi* (all 58.33%). The species with the largest populations were *Carychium exile* (283.08 individuals/sample), *Vallonia gracilicosta* (245.08), *Punctum minutissimum* (160.58), *Nesovitrea electrina* (110.5), *Strobilops labyrintbica* (99.42), and *Carychium exiguum* (95.25).

Species	Occurrences	% Frequency	# Individuals	Average
Zonitoides arboreus	12	100.00	328	27.33
Nesovitrea electrina	11	91.67	1326	110.50
Carychium exile	10	83.33	3397	283.08
Punctum minutissimum	10	83.33	1927	160.58
Carychium exiguum	10	83.33	1143	95.25
Cochlicopa lubricella -	10	83.33	813	67.75
Gastrocopta tappaniana	10	83.33	487	40.58
Strobilops labyrintbica	9	75.00	1193	99.42
Striatura milium	9	75.00	835	69.58
Nesovitrea binneyana	9	75.00	275	22.92
Euconulus fulvus	9	75.00	134	11.17
Vertigo elatior	9	75.00	114	9.50
Vallonza gracilicosta	8	66.67	2941	245.08
Hawaiia minuscula	8	66.67	303	25.25
Vertigo arthuri	7	58.33	93	7.75
Columella simplex	7	58.33	55	4.58
Vertigo nylanderi	7	58.33	37	3.08
Discus cronkhitei	6	50.00	682	56.83
Discus catskillensis	6	50.00	606	50.50
Euconulus alderi	6	50.00	186	15.50
Gastrocopta pentodon	6	50.00	142	11.83
Cochlicopa lubrica	5	41.67	906	75.50

Gastrocopta contracta	5	41.67	243	20.25
Hell codices parallelus	5	41.67	107	8.92
Striatura exigua	5	41.67	99	8.25
Vitrina limpida	5	41.67	71	5.92
Deroceras laeve	5	41.67	8	0.67
Succinea ovalis	4	33.33	235	19.58
Punctum n.sp.	4	33.33	33	2.75
Zonitoides nitidus	3	25.00	89	7.42
Catinella avara	3	25.00	12	1.00
Anguispira alternata	2	16.67	28	2.33
Vertigo ovata	2	16.67	12	1.00
Gastrocopta similis	1	8.33	74	6.17
Vallonia pulchella	1	8.33	28	2.33
Vallonia costata	1	8.33	23	1.92
Oxyloma retusa	1	8.33	13	1.08
Gastrocopta holzingeri	1	8.33	10	0.83
Catinella exile	1	8.33	6	0.50
Vertigo cristata	1	8.33	1	0.08
Vertigo paradoxa	1	8.33	1	0.08

C Tamarack Swamp Forest (26 sites).

Like the previous habitat, Tamarack wetlands are essentially limited to the eastern half of the study region, being most frequent in the Agassiz Lowlands, Pine Moraines, with some scattered outliers existing in the Leaf Hills. 39 species and 493 individuals/sample were recorded from these sites. The most frequently encountered species were *Nesovitrea electrina, Vertigo elatior* (both 100% of sites), *Euconulus alderi, Striatura milium* (both 92.31%), *Carychium exiguum* (88.46%), *Gastrocopta tappaniana* (84.62%), *Zonitoides arboreus* (80.77%), and *Vertigo nylanderi (*76.92%). The species with the largest average populations were *Carychium exiguum* (135.08 individuals/sample), *Nesovitrea electrina* (51.23), *Carychium exile* (40.38), *Punctum minutissimum (*34.19), *Striatura milium* (33.08), and *Strobilops labyrintbica* (32.5).

Species	Occurrences	% Frequency	# Individuals	Average
Nesovitrea electrina	26	100.00	1332	51.23
Vertigo elatior	26	100.00	275	10.58
Striatura milium	24	92.31	860	33.08
Euconulus alderi	24	92.31	318	12.23
Carychium exiguum	23	88.46	3512	135.08
Gastrocopta tappaniana	22	84.62	631	24.27
Zonitoides arboreus	21	80.77	252	9.69
Vertigo nylanderi	20	76.92	192	7.38
Punctum minutissimum	17	65.38	889	34.19
Strobilops labyrintbica	15	57.69	845	32.50

Discus cronkhitei	14	53.85	123	4.73
Columella simplex	14	53.85	54	2.08
Discus catskillensis	13	50.00	521	20.04
Carychium exile	12	46.15	1050	40.38
Cochlicopa lubricella	10	38.46	180	6.92
Punctum n.sp.	10	38.46	133	5.12
Nesovitrea binneyana	9	34.62	166	6.38
Striatura exigua	8	30.77	247	9.50
Vertigo cristata	8	30.77	27	1.04
Deroceras laeve	8	30.77	18	0.69
Vertigo arthuri	6	23.08	71	2.73
Euconulus fulvus	5	19.23	58	2.23
Catinella avara	5	19.23	25	0.96
Vallonia gracilicosta	4	15.38	101	3.88
Cochlicopa lubrica	4	15.38	17	0.65
Vertigo ovata	4	15.38	10	0.38
Gastrocopta contracta	2	7.69	50	1.92
Gastrocopta pentodon	2	7.69	30	1.15
Succinea ovalis	2	7.69	15	0.58
Hawaiia minuscula	2	7.69	11	0.42
Oxyloma retusa	2	7.69	7	0.27
Vertigo paradoxa	2	7.69	4	0.15
Anguispira alternata	2	7.69	2	0.08
Vallonia pulchella	1	3.85	13	0.50
Helicodiscus parallelus	1	3.85	7	0.27
Strobilops affinis	1	3.85	6	0.23
Vitrina limpida	1	3.85	6	0.23
Catinella exile	1	3.85	1	0.04
Zonitoides nitidus	1	3.85	1	0.04

D. White Cedar Swamp Forest (6 sites).

Sites were limited to the Agassiz Lowlands, and often supported thick leaf litter layers in conjunction with diverse bryophyte and herb groundlayers. Sites ranged from wet to almost Mesic, with the most diverse faunas being recorded from the most hydric sites. 25 species and 489 individuals/sample were recorded. The most frequently encountered taxa were *Discus catskillensis, Gastrocopta tappaniana, Nesovitrea binneyana, Punctum minutissimum, Striatura milium, Strobilops labyrintbica, Zonitoides arboreus* (all 100% of sites), *Carychium exile* (91.83%), *Nesovitrea electrina, Vertigo artburi* (both 83.33%). The most abundant species were *Carycbium exile* (91.83 individuals/sample), *Carychium exiguum* (59), *Striatura milium* (55.67), *Strobilops labyrintbica* (46.33), *Punctum minutissimum* (38.33), and *Discus catskillensis* (30.33).

Species	Occurrences	% Frequency	# Individuals	Average
Striatura milium	6	100.00	334	55.67

Strobilops labyrinthica	6	100.00	278	46.33
Punctum minutissimum	6	100.00	230	38.33
Discus catskillensis	6	100.00	182	30.33
Nesovitrea binneyana	6	100.00	131	21.83
Gastrocopta tappaniana	6	100.00	112	18.67
Zonitoides arboreus	6	100.00	44	7.33
Carychium exile	5	83.33	551	91.83
Nesovitrea electrina	5	83.33	116	19.33
Vertigo arthuri	5	83.33	17	2.83
Cochlicopa lubricella	4	66.67	44	7.33
Discus cronkhitei	4	66.67	37	6.17
Euconulus alderi	4	66.67	37	6.17
Columella simplex	4	66.67	11	1.83
Carychium exiguum	3	50.00	354	59.00
Euconulus fulvus	3	50.00	47	7.83
Vertigo paradoxa	3	50.00	47	7.83
Vertigo cristata	3	50.00	25	4.17
Vallonia gracilicosta	3	50.00	21	3.50
Striatura exigua	2	33.33	86	14.33
Vertigo elation	2	33.33	28	4.67
Helicodiscus parallelus	1	16.67	28	4.67
Vertigo nylanderi	1	16.67	4	0.67
Vertigo bollesiana	1	16.67	1	0.17
Vertigo ovata	1	16.67	1	0.17

E. Black Spruce Swamp Forest (3 sites)

These sites were generally limited to the Agassiz Lowlands, although some very good examples were also noted in the Pine Moraines. While dominated by Black Spruce, they also support Tamarack and occasionally White Cedar. The ground layer can be extraordinarily rich in both bryophytes and herbs, with little Sphagnum moss being present. 26 species and 469 individuals/sample were recorded. Species found on all three sites were *Columella simplex, Discus catskillensis, Euconulus alderi, Gastrocopta tappaniana, Nesovitrea electrina, Striatura militim, Vertigo elatior, Vertigo nylanderi*, and *Zonitoides arboreus*. The most abundant species were *Carychium exiguum* (70.67 individuals/site), *Striatura milium* (43), *Nesovitrea electrina* (42), *Discus catskillensis* (28.33), *Cochlicopa lubrica* (25), *Striatura exigua* (24), and *Strobilops labyrinthica* (22.33).

Species	Occurrences	% Frequency	# Individuals	Average
Striatura milium	3	100.00	129	43.00
Nesovitrea electrina	3	100.00	126	42.00
Discus catskillensis	3	100.00	85	28.33
Zonitoides arboreus	3	106.00	56	18.67
Vertigo elatior	3	100.00	54	18.00

Euconulus alderi	3	100.00	52	17.33
Gastrocopta to paniana	3	100.00	45	15.00
Vertigo nylanderi	3	100.00	19	6.33
Columella situ lex	3	100.00	15	5.00
Carychium exiguum	2	66.67	212	70.67
Striatura exigua	2	66.67	72	24.00
Strobilops labyrinthica	2	66.67	67	22.33
Punctum n.sp.	2	66.67	47	15.67
Nesovitrea binneyana	2	66.67	18	6.00
Vertigo cristata	2	66.67	10	3.33
Cochlicopa lubrica	1	33.33	75	25.00
Carychium exile	1	33.33	58	19.33
Hawaiia minuscula	1	33.33	56	18.67
Punctum minutissimum	1	33.33	24	8.00
Euconulus fulvus	1	33.33	18	6.00
Catinella avara	1	33.33	14	4.67
Helicodiscus parallelus	1	33.33	11	3.67
Cochlicopa lubricella	1	33.33	2	0.67
Deroceras laeve	1	33.33	2	0.67
Discus cronkhitei	1	33.33	1	0.33
Strobilops affins	1	33.33	1	0.33

F. Shrub Carr (3 sites).

This habitat occurs throughout the study region, often along stream margins, or in areas of groundwater seepage. Sites are dominated by a mix of willow, alder, and dogwood, and often support a dens sedge groundcover. 29 species and 1249 individuals/sample were observed from these sites. Species observed on all 3 sites were *Carychium exiguum, Discus cronkhitei, Euconulus alderi, Nesovitrea electrina, Vertigo elatior, and Zonitoides arboreus.* The most abundant species were *Carychium exiguum* (364.33 individuals/sample), Gastrocopta *tappaniana* (13 x..33), *Nesovitrea electrina* (130.67), *Strobilops labyrintbica* (94.33), *Euconulus alderi* (93), *and Punctum* n.sp. (85).

Species	Occurrences	% Frequency	# Individuals	Average
Carychium exiguum	3	100.00	1093	364.33
Nesovitrea electrina	3	100.00	392	130.67
Euconulus alderi	3	100.00	279	93.00
*Discus cronkhitei**	3	100.00	172	57.33
Vertigo elatior	3	100.00	133	44.33
Zonitoides arboreus	3	100.00	34	11.33
Gastrocopta tappaniana	2	66.67	394	131.33
Gastrocopta contracta	2	66.67	47	15.67
Oxyloma retusa	2	66.67	37	12.33
Deroceras laeve	2	66.67	9	3.00

Hawaiia minuscula	2	66.67	3	1.00
Vallonia pulchella	2	66.67	2	0.67
Strobilops labyrinthica	1	33.33	283	94.33
Punctum n.sp.	1	33.33	255	85.00
Punctum minutissimum	1	33.33	66	22.00
Zonitoides nitidus	1	33.33	54	18.00
Carychium exile	1	33.33	41	13.67
Strobilops affinis	1	33.33	30	10.00
Succinea ovalis	1	33.33	22	7.33
Cochlicopa lubrica	1	33.33	19	6.33
Punctum vitreurn	1	33.33	19	6.33
Vallonia gracilicosta	1	33.33	16	5.33
Cochlicopa lubricella	1	33.33	10	3.33
Vertigo ovata	1	33.33	9	3.00
Discus catskillensis	1	33.33	8	2.67
Catinella avara	1	33.33	3	1.00
Vallonia costata	1	33.33	3	1.00
Vallonia perspectiva	1	33.33	2	0.67
Vertigo milium	1	33.33	1	0.33

3. Upland Grasslands.

A. Mesic Prairie (7 sites).

These sites were all limited to the Red River Valley province in the western third of the study region. While snails were most often found in leaf litter under native shrubs such as hazel, leadplant, and, snowberry, they were also commonly seen in dense thatch. 24 species and 414 individuals/sample were recorded. The most frequently encountered species were *Hawaiia minuscula, Nesovitrea electrina* (both 100% of sites), *Catinella avara, Punctum minutissimum* (both 85.71%), *Gastrocopta holzingeri, Gastrocopta tappaniana, Vallonia gracilicosta, Vertigo milium*, and *Zonitoides arboreus* (all 71.43%). The most abundant species were *Hawaiia minuscula* (48.57 individuals/sample), *Punctum minutissimum, Vallonia gracilicosta* (both 48.14), *Catinella avara* (35.71), *Vertigo milium* (31.86), *Vallonia pulchella* (28.43), *Nesovitrea electrina* (24.57), *Gastrocopta holzingeri* (21.14), and *Gastrocopta tappaniana* (18). These faunas, as well as those of other grassland habitats in the region were shown to show serious negative impacts to fire', with managed sites demonstrating 33% reductions in richness, and abundance decreasing by up to an order of magnitude (Nekola, in press). Protection of the land snail fauna of grassland sites will require that fire return intervals be lengthened (perhaps up to 20 years) to allow full redevelopment of thatch microsites in which these species live.

Species	Occurrences	% Frequency	# Individuals	Average
Hawaiia minuscula	7	100.00	340	48.57
Nesovitrea electrina	7	100.00	172	24.57
Punctum minutissimum	6	85.71	337	48.14

Catinella avara	6	85.71	250	35.71
Vallonia gracilicosta	5	71.43	337	48.14
Vertigo milium	5	71.43	223	31.86
Gastrocopta holzingeri	5	71.43	148	21.14
Gastrocopta tappaniana	5	71.43	126	18.00
Zonitoides arboreus	5	71.43	35	5.00
Vallonia pulchella	4	57.14	199	28.43
Vertigo ovata	4	57.14	39	5.57
Vallonia perspectiva	4	57.14	35	5.00
Vallonia costata	3	42.86	74	10.57
Euconulus fulvus	3	42.86	68	9.71
Discus cronkhitei	3	42.86	45	6.43
Euconulus alderi	3	42.86	8	1.14
Helicodiscus parallelus	3	42.86	5	0.71
Carychium exiguum	2	28.57	15	2.14
Oxyloma retusa	2	28.57	7	1.00
Cochlicopa lubricella	1	14.29	37	5.29
Gastrocopta sir ilis	1	14.29	21	3.00
Punctum vitreum	1	14.29	12	1.71
Deroceras laeve	1	14.29	2	0.29
Vitrina limpida	1	14.29	2	0.29

B. Xeric Prairie (4 sites).

Again, sites were limited to the Red River Valley in the western third of the study region. Most of these sites were found on gravel deposits associated with moraines or outwash fans. Vegetation, and thatch, was sparse in most places. The majority of individuals were found in leaf litter under prairie shrubs. 16 species and 208 individuals/sample were recorded. The most frequently encountered species were *Gastrocopta holzingeri* (100% of sites), *Euconulus fulvus, Gastrocopta similis, Hawaiia minuscula, Nesovitrea electrina, Punctum minutissimum, Vallonia gracilicosta, Vallonia parvula* and *Zonitoides arboreus* (all 50%). The most abundant species were *Gastrocopta holzingeri* (91.5 individuals/sample), *Vallonia parvula* (16.5), *Punctum minutissimum* (15.75), *Nesovitrea electrina* (13.25), and *Nesovitrea binneyana* (11.5).

Species	Occurrences	% Frequency	# Individuals	Average
Gastrocopta holzingeri	4	100.00	366	91.50
Vallonia parvula	2	50.00	66	16.50
Punctum minutissimum	2	50.00	63	15.75
Nesovitrea electrina	2	50.00	53	13.25
Euconulus fulvus	2	50.00	34	8.50
Gastrocopta similis	2	50.00	13	3.25
Vallonia gracilicosta	2	50.00	11	2.75
Hawaiia minuscula	2	50.00	7	1.75
Zonitoides arboreus	2	50.00	5	1.25

Nesovitrea binneyana	1	25.00	46	11.50
Strobilops labyrinthica	1	25.00	39	9.75
Vallonia perspectiva	1	25.00	25	6.25
Gastrocopta contracta	1	25.00	13	3.25
Vitrina limpida	1	25.00	3	0.75
Catinella 'vermeta'	1	25.00	2	0.50
Vallonia costata	1	25.00	1	0.25

C Sand Prairie (2 sites).

Sand prairies in the region are generally limited to the former dune ridges of Land Agassiz, although a limited number of sites also occur on sandy outwash plains on the western margin of the Pine Moraines province. These sites supported only 15 species, and 150 individuals/sample, the lowest of all habitats sampled. Snails were essentially absent from open sand, and were limited to leaf litter accumulations under native shrubs, especially hazel and choke cherry and sand cherry. Only *Gastrocopta holzingeri* was found at both sites. The most abundant species were *Punctum minutissimum* (26 individuals/sample), *Gastrocopta holzingeri* (22), *Striatura milium* (17.5), and *Nesovitrea binneyana* (16.5).

Species	Occurrences	% Frequency	# Individuals	Average
Gastrocopta holzingeri	2	100.00	44	22.00
Punctum minutissimum	1	50.00	52	26.00
Striatura milium	1	50.00	35	17.50
Nesovitrea binneyana	1	50.00	33	16.50
Hawaiia minuscula	1	50.00	26	13.00
Cochlicopa lubricella	1	50.00	22	11.00
Zonitoides arboreus	1	50.00	20	10.00
Vitrina limpid	1	50.00	13	6.50
Helicodiscus parallelus	1	50.00	12	6.00
Vallonia gracilicosta	1	50.00	12	6.00
Euconulus fulvus	1	50.00	11	5.50
Vallonia perspectiva	1	50.00	2	1.00
Carychium exiguum	1	50.00	1	0.50
Gastrocopta pentodon	1	50.00	1	0.50

D. Old Field (1 site).

A single old field was sampled, as the purpose of this study was an inventory of natural habitats. As analysis of this single sites was done via field sieving, the data gathered cannot be compared to the other data. This site harbored one of the two populations for *Gastrocopta abbreviata* and *Vertigo pygmaea*. Additional survey of these habitats would likely be useful, especially give how common they are in the modern landscape.

4. Lowland Grasslands.

A. Wet Prairie (11 sites).

These habitats) were restricted to the Red River Valley and Aspen Parkland provinces in the western third of the study region. Included are brush prairie sites that have up to 75% of their surface area covered by willow, aspen, and shrubby cinquefoil scrub. Snails were generally restricted to areas of deep thatch, and to leaf litter accumulations under shrubs. 36 species and 818 individuals/sample were observed on these sites. The most frequently encountered species were *Gastrocopta tappaniana* (90.91% of sites), *Catinella avara, Euconulus alderi, Nesovitrea electrina, Vertigo milium* (all 81.82%), *Deroceras* spp., *Discus cronkhitei, Hawaiia minuscula* (all 72.73%), *Oxyloma retusa, Punctum minutissimum, Vallonia gracilicosta, Vertigo ovata,* and *Zonitoides arboreus* (all 63.64%). The most abundant species were *Punctum minutissimum* (99.82 individuals/site), *Vallonia pulchella* (86.55), *Carychium exiguum* (81.09), *Gastrocopta tappaniana* (75,191), and *Vertigo milium* (54.64).

Species	Occurrences	% Frequency	# Individuals	Average
Gastrocopta tappaniana	10	90.91	835	75.91
Vertigo milium	9	81.82	601	54.64
Nesovitrea electrina	9	81.82	407	37.00
Euconulus alderi	9	81.82	343	31.18
Catinella avara	9	81.82	236	21.45
Hawaiia minuscula	8	72.73	334	30.36
Discus cronkhitei	8	72.73	92	8.36
Deroceras laeve	8	72.73	12	1.09
Punctum minutissimum	7	63.64	1098	99.82
Vallonia gracilicosta	7	63.64	439	39.91
Oxyloma retusa	7	63.64	294	26.73
Vertigo ovata	7	63.64	205	18.64
Zonitoides arboreus	7	63.64	73	6.64
Vallonia pulchella	5	45.45	952	86.55
Carychium exiguum	5	45.45	892	81.09
Vertigo elatior	5	45.45	215	19.55
Gastrocopta holingeri	4	36.36	72	6.55
Cochlicopa lubricella	4	36.36	43	3.91
Gastrocopta contracta	3	27.27	22	2.00
Vallonia costata	2	18.18	89	8.09
Vertigo arthuri	2	18.18	34	3.09
Vallonia perspectiva	1	9.09	71	6.45
Carychium exile	1	9.09	51	4.64
Cochlicopa lubrica	1	9.09	26	2.36
Strobilops labyrinthica	1	9.09	13	1.18
Euconulus fulvus	1	9.09	11	1.00
Gastrocopta similis	1	9.09	6	0.55

Punctum n.sp	1	9.09	6	0.55
Nesovitrea binneyana	1	9.09	5	0.45
Vertigo morsel	1	9.09	4	0.36
Striatura milium	1	9.09	3	0.27
Vitrina limpida	1	9.09	3	0.27
Discus catskillensis	1	9.09	1	0.09
Gastrocopta abbreviata	1	9.09	1	0.09
Succinea ovalis	1	9.09	1	0.09
Zonitoides nitidus	1	9.09	1	0.09

B. Sedge Meadow (3 sites).

Sedge meadows occur throughout the region where wet, mineral soils are covered by a dense growth of sedges. Scattered dogwood, alder, and willow shrubs are also commonly present. Snails were most frequently encountered in thatch and in leaf litter under shrubs. *31* species and 1903 individuals/sample were observed on these sites. Species found on all sites were *Carychium exiguum, Discus cronkhitei, Euconulus alderi, Gastrocopta tappaniana, Nesovitrea electrina, Punctum* n.sp., and *Vertigo elation*. The most abundant species were *Carychium exiguum* (336.7 individuals/sample), *Strobilops labyrinthica* (197.67), *Carychium exile* (126.33), *Hawaiia minuscula* (105), *Striatura milium* (100), *Nesovitrea electrina* (99.67), *Cochlicopa lubrica* (99.33); *Punctum minutissimum* (95), *Gastrocopta tappaniana* (84), and *Vallonia pulchella* (81.33).

Species	Occurrences	% Frequency	# Individuals	Average
Carychium exiguum	3	100.00	1010	336.67
Nesovitrea electrina	3	100.00	299	99.67
Gastrocopta tappaniana	3	100.00	252	84.00
Punctum n.sp.	3	100.00	172	57.33
Vertigo elatior	3	100.00	148	49.33
Euconulus alderi	3	100.00	132	44.00
Discus cronkhitei	3	100.00	7	2.33
Carychium exile	2	66.67	379	126.33
Discus catskillensis	2	66.67	144	48.00
Vertigo ovata	2	66.67	86	28.67
Zonitoides arboreus	2	66.67	52	17.33
Succinea ovalis	2	66.67	30	10.00
Strobilops labyrinthica	1	33.33	593	197.67
Hawaiia minuscula	1	33.33	315	105.00
Striatura milium	1	33.33	300	100.00
Cochlicopa lubrica	1	33.33	298	99.33
Punctum minutissimum	1	33.33	285	95.00
Vallonia pulchella	1	33.33	244	81.33
Oxyloma retusa	1	33.33	176	58.67
Gastrocopta contracta	1	33.33	98	32.67

Cochlicopa lubricella	1	33.33	89	29.67
Vallonia gracilicosta	1	33.33	34	11.33
Vertigo arthuri	1	33.33	24	8.00
Euconulus fulvus	1	33.33	23	7.67
Vitrina limpida	1	33.33	13	4.33
Gastrocopta holzingeri	1	33.33	12	4.00
Nesovitrea binneyana	1	33.33	4	1.33
Catinella avara	1	33.33	3	1.00
Striatura exigua	1	33.33	3	1.00
Vertigo milium	1	33.33	3	1.00
Deroceras laeve	1	33.33	1	0.33

C. Fen (17 sites).

Fens are found, in three very different situations in the study region. The most extensive fen areas are found in areas of groundwater discharge within the extensive peatland areas of the Agassiz lowlands. These sites are often very wet, with the only terrestrial habitats being found on shrubs that have colonized strings in these patterned peatlands. Fens also are found in the Pine Moraines and Leaf Hills provinces along shores of nutrient-rich lakes, where marl beds may develop. The majority of sampled sites, however, were associated with local groundwater discharge associated with former Lake Agassiz beach ridges in the Red River Valley province, as these sites were hypercalcareous, and supported a very rich flora. These sites supported', the most abundant and diverse fen snail communities, with up to 5000 individuals occurring per sample. 34 species and a mean of 1878 individuals/sample were recorded from these sites. The most frequently encountered species were *Carychium exiguum, Euconulus alderi, Nesovitrea electrina* (all 100% of sites), *Gastrocopta tappaniana* (94.12%), *Oxyloma retusa*, (88.24%), *Vertigo elatior* (82.35%), *Punctum* n.sp, *Zonitoides arboreus* (both 76.47%), and *Vertigo milium* (70.59%). The most abundant species were *Carychium exiguum* (421.76 individuals/sample), *Gastrocopta tappaniana* (214.53), *Catinella exile* (152.76), *Nesovitrea electrina* (130.59), *Punctum* n.sp. (89.65), and *Euconulus alderi* (81.12).

Species	Occurrences	% Frequency	# Individuals	Average
Carychium exiguum	17	100.00	7170	421.76
Nesovitrea electrina	17	100.00	2220	130.59
Euconulus alderi	17	100.00	1379	81.12
Gastrocopta tappaniana	16	94.12	3647	214.53
Oxyloma retusa	15	88.24	870	51.18
Vertigo elatior	14	82.35	1069	62.88
Punctum n.sp.	13	76.47	1524	89.65
Zonitoides arboreus	13	76.47	83	4.88
Vertigo milium	12	70.59	1166	68.59
Discus cronkhitei	11	64.71	771	45.35
Vertigo morsei	11	64.71	179	10.53
Catinella exile	9	52.94	2597	152.76

Hawaiia minuscula	9	52.94	876	51.53
Strobilops labyrinthica	7	41.18	241	14.18
Deroceras laeve	6	35.29	64	3.76
Punctum minutissimum	5	29.41	134	7.88
Catinella avara	5	29.41	86	5.06
Strobilops affinis	4	23.53	490	28.82
Vertigo ovata	4	23.53	114	6.71
Vallonia pulchella	4	23.53	103	6.06
Gastrocopta contracta	4	23.53	65	3.82
Vallonia gracilicosta	4	23.53	29	1.71
Vertigo nylanderi	3	17.65	25	1.47
Discus catskillensis	3	17.65	20	1.18
Carychium exile	2	11.76	239	14.06
Zonitoides nitidus	2	11.76	25	1.47
Striatura milium	2	11.76	2	0.12
Succinea ovalis	2	11.76	2	0.12
Hawaiia n.sp.	1	5.88	31	1.82
Columella simplex	1	5.88	4	0.24
Punctum vitreum	1	5.88	4	0.24
Vertigo arthuri	1	5.88	2	0.12
Helicodiscus parallelus	1	5.88	1	0.06
Vitrina limpida	1	5.88	1	0.06

D. Calcareous ,Meadow (4 sites).

This habitat is (found in highly calcareous situations where wet, bare mineral soil is exposed. Vegetation is sually quite low in stature. Most of these sites were created by human activities, especially the creation and maintenance of road ditches and railroad right-of-ways. However, one natural site was observed in Kittson County where a deposit of calcareous mineral soil roe above surrounding ponded wetland. 23 species and 1064 individuals/sample were observed on these sites. The most frequently encountered species were *Gastrocopta tappaniana, Vertigo elation* (both 100% of sites), *Carychium exiguum, Euconulus alderi, Nesovitrea electrina, Punctum minutissimum,* and *Zonitoides arboreus* (all 75%). The most abundant species were *Vertigo elatior* (202 individuals/sample), *Vertigo milium* (102.25), *Gastrocopta tappaniana* (88.5), *Nesovitrea electrina* (80.5), *Vallonia pulchella* (67.75), and *Euconulus alderi* (57.5).

Species	Occurrences	% Frequency	# Individuals	Average
Vertigo elation	4	100.00	808	202.00
Gastrocopta tappaniana	4	100.00	354	88.50
Nesovitrea electrina	3	75.00	322	80.50
Euconulus alderi	3	75.00	230	57.50
Carychium exig uum	3	75.00	174	43.50
Punctum minutissimum	3	75.00	128	32.00

Zonitoides arboreus	3	75.00	22	5.50
Vertigo milium	2	50.00	409	102.25
Vertigo ovata	2	50.00	80	20.00
Gastrocopta holzingeri	2	50.00	28	7.00
Catinella avara	2	50.00	25	6.25
Hawaiia minuscula	2	50.00	8	2.00
Vallonia pulchella	1	25.00	271	67.75
Vallonia costata	1	25.00	190	47.50
Cochlicopa lubricella	1	25.00	24	6.00
Vallonia gracilicosta	1	25.00	23	5.75
Gastrocopta contracta	1	25.00	21	5.25
Gastrocopta similis	1	25.00	9	2.25
Cochlicopa lubrica	1	25.00	8	2.00
Deroceras laeve	1	25.00	6	1.50
Euconulus fulvus	1	25.00	1	0.25
Strobilops labyrinthica	1	25.00	1	0.25
Vitrina limpida	1	25.00	1	0.25

3. Species Richness and Abundance Patterns.

1. Habitat relationships.

30 sites (17% of total) were found to harbor 20 or more species. Two of these were Oak forests, 2 Maple-Basswood forests, 7 Aspen forests, 8 Black Ash wetlands, 6 Tamarack wetlands, 1 White Cedar wetland, 1 Black Spruce wetland, 2 Wet prairies, and 1 Sedge Meadow. The maximum observed site richness scores were 25 at Bear Paw Point East and Strathcona SW, 26 at the Lake Bronson wooded ravine, and 27 at Halma Swamp WMA. The lowest recorded richness levels were 2 taxa at Chicog Prairie and 3 on the open dunes at Prairie Smoke Dunes.

Mean site richness significantly ($p < 0.0005$) and rather strongly ($r^2=0.284$) varied among the 20 habitats sampled via litter collection (Figure 2). Black Ash swamp forests had the highest values at 19.7 taxa/site. Maple-Basswood forest and Black Spruce swamp forest had means of 17.7-17.8, respectfully. Oak forest, Sedge meadow, Balsam-White Spruce forest, White Cedar forest, Shrub Carr Aspen forest, and Tamarack swamp forest had means ranging from 15.016.8. Floodplain forest, Wet prairie, Fen, and Red Pine forest ranged from 13.25-14.0. Mesic prairie, Paper Birch forest, Jack Pine forest, and Calcareous meadow ranged between 11.25 and 12.6. The most species poor communities were Sand (8) and Xeric prairie (6.75). Highly significant ($p < 0.0005$), but less strong (r^2 - 0.141) differences were also noted between the four major habitat groups (Figure 3). Lowland forests had the highest mean richness (16.4), followed by upland forest (14.3), lowland grassland (13.6), and upland grassland (9.4).

21 sites (12% of total) were found to harbor 2000 or more individuals per litter sample. Two of these were Maple-Basswood forests, 3 Aspen forests, 3 Black Ash wetlands, 1 Tamarack

wetland, 1 Shrub Carr, 1 Sedge Meadow, 9 Fens, and 1 Calcareous Meadow. The maximum observed abu dances were 5492 at Strathcona SW, 5001 at Ogema West, 4232 at Halma Swamp WMA, and 3923 at Florian Fen. The lowest number observed was 19 individuals at the open dun' at Prairie Smoke Dunes.

Mean abundance significantly ($p < 0.0005$) and rather strongly ($r^2=0.290$) varied among the 20 habitats sampled via litter collection (Figure 4). Sedge Meadows had the highest at 1902.7 individuals/sample, followed closely by Fen at 1877.5, and Black Ash swamp forest at 1617.7. Shrub Carr, Calcareous meadow, and Maple-Basswood forest had means ranging from 1044.9-1249.3. Aspen forest, Wet prairie, and Oak forest averaged 877.6, 817.8, and 569.2 individuals/sample respectively. Jack Pine forest, Tamarack wetland, White Cedar wetland, Red Pine fore t, Black Spruce wetland, Floodplain forest, and Mesic prairie had mean abundances ranging from 414.4-495.0. The habitat with the lowest mean abundances were Balsam-White !Spruce forest (286), Paper Birch forest (234.5), Xeric prairie (207.8) and Sand prairie (150). Highly significant ($p < 0.0005$) differences were also noted between the four major habitat groups (Figure 5). Lowland grasslands had the highest mean abundance (1453.6), followed by lowland forest (792.5), upland forest (687.9), and upland grassland (288.7).

B. Geographic relationships.

Total species richness per county (Table 5a-b) was fairly consistent, generally ranging from the upper 30's to chid 40's, with the lowest being 30 (Hubbard) and the highest 47 (Clearwater).

Average richness per site was found to possess only a non-significant ($p=0.079$) trend between counties (Figure 6). Kittson County sites possessed the highest values (19.22), followed by Becker and Clearwater (16.5 and 16.4, respectfully), Pennington, Marshall, Red Lake, Mahnomen, Lake of the Woods, Roseau, Norman, and Beltrami (14.2-15.75), Hubbard (13.6), Clay (13.0), and Polk (12.5). Highly significant variation in mean site richness was noted, however, between the 5 physiographic provinces (Figure 7). Aspen Parkland, Leaf Hills, Pine Moraines and Agassiz Lowlands all possessed similar averages (16.9-15.1), while Red River Valley sites were considerably lower (12.7). The kriged response surface of this data over the study region (Figure 8) demonstrates the highest average site richness scores (15.6-18.7 taxa) were limited to! the Aspen Parklands of the northwest and a crescent-shaped area in the southeast. Lowest site richness (< 14.1 values were seen along the bulk of the Red River Valley (especially in the west-central), and in the east-central.

Average snail abundance per sample possessed significant ($p=0.011$) variation between counties (Figure 9), being highest in Marshall, Kittson, and Norman counties (1469.8-1537.0). Becker Count followed at (1236.1). Pennington, Red Lake, and Clay counties had similar values (916.3-1(61.4), followed by Polk, Mahnomen, Clearwater, and Roseau (655.5-761.2). The counties with the lowest average number of individuals per sample were Hubbard (508.3), Beltrami (499.20, and Lake of the Woods (450.1). Not surprisingly, highly significant ($p=0.008$) variation in snail abundance was also noted between the 5 physiographic provinces

(Figure 10). Aspen Parkland and Red River Valley sites possessed the most average number of individuals pear sites (1084.2-1224.3), with Agassiz Lowlands, Pine Moraines, and Leaf Hills sites have mush lower values (527.7-728.5). The kriged response surface of this data over the study region (figure 11) clearly demonstrated this variation, with highest scores (1239-1780) being limited o the southwest and northwest corners. Again, Aspen Parkland landscapes in Kittson, Marshall, and western Roseau counties demonstrated the highest values over the landscape. Abundance fell so that essentially the entire eastern third of the region had less than 698 individuals, on average, per site.

These analyse, demonstrate that the richest land snail habitats in the region tend to be mature wooded wetland (especially Black Ash and Black Spruce) and upland (Basswood and Oak) forest, all that tend to have deep soil humus layers. Grassland sites tend to have lower average richness value,. Highest abundance, however, is typically found in lowland grassland habitats such as Sedge meadows, Fens, and Calcareous meadows. High snail abundance also occurs in Black Ash swamp forest, Basswood forest, and Shrub Carr. Thus, in terms of both richness and abundance, Black Ash swamp forests are one of the most important reservoirs of land snail biodiversity in the region. Basswood-dominated forests with deep humus layers are also important. Interpolation of these data across the region indicated that the Aspen Parkland landscape is ore of the most important reservoirs of land snail biodiversity, harboring both the highest average site richness and abundance levels. What is not clear, however, is why the Red River Valley has the lowest mean site richness, but has one of the highest average site abundances.

It is also important to remember that while the eastern parts of the study region have, on average, low site richness and abundance, this should not indicate that these areas are unimportant to land snail conservation. In fact, a number of species, including some of the most biogeographically interesting (e.g. *Vertigo cristata, Vertigo nylanderi, Vertigo paradoxa)* are limited to sites in the east. Thus, protection of this fauna will require the maintenance of sites throughout the region.

4. Species Distribution Patterns

Distribution maps for all encountered species are found in Appendix I. Through visual inspection of these maps combined with the results of the Fisher's Exact test for changes in frequency between physiographic provinces (Table 4), four major distribution classes can be identified.

25 species (46% of total) can be considered cosmopolitan, as they are found across the entire study region at essentially equal frequencies. These species include: *Anguispira alternata, Carychium exiguum, Carychium exile, Catinella avara, Cochlicopa lubrica, Cochlicopa lubricella, Discus catskillensis, Discus cronkhitei, Euconulus alderi, Euconulus fulvus, Gastrocopta tappaniana, Nesovitrea binneyana, Nesovitrea electrina, Oxyloma retusa, Punctum minutissimum, Punctum* n.sp., *Striatura milium, Strobilops labyrinthica, Vallonia gracilicosta, Vertigo arthuri,Vertigo elatior, Vertigo ovata, Vitrina limpida, Zonitoides arboreus,* and *Zonitoides nitidus.*

The second largest group are those species (19, 35% of total) limited to, or most frequent in, the west and south. These species are generally more frequent in grassland habitats, or are more southern in distribution. These species include: *Catinella exile, Catinella 'vermeta', Deroceras spp., Gastrocopta abbreviata, Gastrocopta contracta, Gastrocopta holzingeri, Gastrocopta pentodon, Gastrocopta similis, Hawaiia miniscula, Succinea ovalis, Vallonia costata, Vallonia parvula, Vallonia perspectiva, Vallonia pulchella, Vertigo milium, Hawaiia* n.sp., *Punctum vitreum, Strobilops afnis,* and *Vertigo morsei.* It is interesting to note that 83% of *Gastrocopta* species, and 80% of *Vallonia* species share this biogeographic distribution.

6 species (11%) are limited to, or more frequent in, the east of the study region. These include: Col *mella simplex, Striatura exigua, Vertigo cristata, Vertigo nylanderi,* and *Vertigo paradoxa.* These species are generally of northeastern or boreal forest affinity, should be expected from additional Minnesota sites Minnesota east of the study region. All of these species, except *V. nylanderi,* were frequent from igneous cliffs along the Lake Superior shoreline in northeastern Minnesota.

The smallest group of species (5; 9%) are those which are most frequent in the southeast. These are: *Helicodiscus parallelus, Pupilla muscorum, Vertigo bollesiana, Vertigo gouldi,* and *Vertigo pygmaea,* and are generally among the rarest species in the region. Their larger affinities are with eastern deciduous forest, although *P. muscorum* and *V. pygmaea* are most common in the eastern U.S. in highly modified, calcareous habitats (such as culverts, abandoned quarries, etc.; Hubricht 1985). Their presence in this region may reflect the greater human recreational impacts in this region, and they may represent recent introductions into the fauna.

5. Land Snail Community Structure.

The nature of how richness varies with snail abundance at a particular site can help interpret the structure of these communities. When comparing raw richness and abundance data (Figure 12), it is clear that a strong richness-abundance relationship only occurs when sample densities fall blow 500 individuals/sample. Above this, no increase in richness occurs. In fact, the Lake Bronson Ravine sites had only 507 individuals but possessed the second-highest richness score (26). Sites with snail densities exceeding 1000 individuals ranged between 11-26 taxa, with the second most-abundant sites (Ogema West; 5001 individuals) supporting only 15 taxa. However, upon log-transformation of abundance data (Figure 12), a significant ($p < 0.0005$) and strong ($r^2=0.328$) linear relationship between richness and density was noted.

The comparison of the relative importance between species can also provide important information regarding the nature of niche partitioning within a community (Whittaker 1975). For these data, the importance of species were estimated by their relative proportion within the entire community. This is essentially a density-based estimate, which should be appropriate in this case as 99% of encountered individuals were microsnails (< 5 mm in maximum dimension), and thus have likely share similar resource utilization and production

rates. When dominance-diversity curves were calculated for either the entire dataset, or individually for the 4 major habitat groups, identical patterns were apparent, with a shallow, negative relationship existing from the most common to all but the most rare species, where the curve sharply dropped off (Figure 14). For the entire dataset, this dropoff occurred at the 5th rarest species, while it occurred from the 3rd to 12th most rare species for individual major habitat groups. These patterns indicate that over the region, land snails strongly exhibit a random niche-boundary structure, in which the resource space is randomly partitioned, and in which there! is little competition between species (Whittaker 1975). This is an unexpected result, as such patterns have generally been recognized for taxonomically related organisms from narrowly-defined, homogeneous communities (Whittaker 1975).

Both of these analyses support the contention that interspecific resource competition may not be an important structuring element for land snail communities, at least at sample grains > $100m^2$ (Cain, 1983; Cowie & Jones, 1987; Smallridge & Kirby, 1988; Barker & Mayhill, 1999). As land, snail communities typically consume less than 0.5% of annual litter input per year (Mason, 1970), some speculate that few resources, beyond $CaC0_3$ (Boycott, 1934) and appropriate resting site availability (Pearce, 1997), will limit distribution. Given the highly calcareous nature of much of northwestern Minnesota soils, and the frequency of thick litter and humus layers (especially in wooded wetlands and mature forests), in this landscape even these resources!, may often not be limiting.

These data also: strongly contradict predictions of the resource-ratio model of competition (Tilman 1988), which states that highest richness will occur at intermediate to low resource supply levels. In this region, however, as resource levels (and land snail numbers) increase, community richness does not fall. These findings support patterns seen in land snail communities at much smaller sample grains (0.04-$100m^2$; Nekola and Smith 1999) suggesting that resource ratio models fail to predict the structure of land snail communities from micro to near-continental scales.

6. Conservation Recommendations

A. Species of Conservation Importance.

Even though this study was prompted by the discovery of some of the most uncommon eastern North American land snails in the region in 1999 (e.g. *Vertigo arthuri, Vertigo nylanderi),* the frequency of these species in the region confirms that none likely warrant legal protection in Minnesota. Additionally, most of the rarest species from the region (e.g. *Gastrocopta similis, Punctum vitreum, Strobilops affinis, Vallonia parvula, Vertigo gouldi)* are . probably common throughout southern Minnesota, given their known distribution in surrounding states, also making them unlikely candidates for listing. Three species in the fauna, however,, probably do warrant listing. Interestingly, all of these species are limited to high quality ferns.

Hawaiia n.sp. was only located at a single station. This population (at Felton Prairie) likely represents its northern range limit. It almost certainly occurs at additional sites to the south, but given its distribution in Iowa and Wisconsin, will likely be limited to a rather few number of high quality fen sites. Until additional information regarding its distribution throughout the remainder of Minnesota is known, listing as Threatened or Special Concern seems most prudent.

Catinella exile was limited to 11 sites, with all but 2 of these representing fens. Like *Hawaiia* n.sp., it is known from high quality fen sites throughout northern Iowa and southern Wisconsin. Given its greater frequency in surrounding landscapes, and thus likely greater frequency in southern Minnesota, listing as Special Concern would appear most warranted.

Vertigo morsei was observed at 12 sites, with 11 representing high quality fens. Unlike the previous two species, which are relatively frequent in Iowa and Wisconsin fens, in these regions this taxon is very rare. I have located previously at only 6 fens, with 3 of these being confined to the northern part of the Door Peninsula in Wisconsin. Frest *(*1990) was only able to locate it on 2 (out of 65) Iowa fens. Hubricht (1985) reports it from only 17 counties in the eastern USA, and it is known from only a single site in Canada (Pilsbry 1948). Most of these sites have not been relocated in over 50 years (Frest 1990). The discovery of *V. morsei* on almost 65% of surveyed fens in the region was unexpected, and suggests that northwestern Minnesota is the modal landscape for this very rare fen-endemic species. Additionally, what is almost certainly its largest global population also occurs at Fourtown Fen. Even though a predictable member of the fen fauna in this region, the few high quality sites, combined with their continual loss due to grazing and altered hydrology, suggests that this species should be listed as Threatened, if for no other reason to ensure its survival and genetic diversity in what likely represents its preferred landscape. If these sites are lost, its long-term survival throughout the rest of its range will brought into serious doubt.

Additionally, three additional taxa *(Pupilla muscorum, Vertigo bollesiana,* and *Vertigo paradoxa)* may also warrant listing at the Special Concern level. This action is less certain for these species are it is not clear that: (1) *P. muscorum* is a native member of this fauna; and (2) that *V. bollesiana* and *V. paradoxa* are rare enough throughout the rest of the state to warrant listing. Additional survey work will be necessary to clarify these issues.

B. Sites and Landscapes of Conservation Importance.

The sites with the richest and/or most abundant land snail populations are Black Ash, Tamarack Swamp & White Cedar swamp forests; old growth Oak, Aspen, and Basswood forests with deep humus and leaf litter; and Fens. Sites of particular importance include: Bemis Hill 1, Cyr Creek, Dunton Locks County Park, Faith Fen, Faunce North, Felton 2 Fen, Fourtown Fen, Halma Swamp WMA, Higenbotham WMA 1, Huot Forest WMA, Lake Bronson State Park 1, Maple Lake Church WPA 1, Norris Camp, Oak Ridge, Ogema Fen, Old Mill State Park, Prairie Smoke Dunes 2, Randeen Ridge, Sanders Fen, Strathcona SW, Turtle Lake 2, Two Island Lake, Two Rivers SNA, and Waubun SE Fen.

By far the most important landscape for land snail biodiversity in the region is the Aspen Parkland in the far northwest, where maximum richness and density were both recorded. Maintenance of exemplary examples of important habitats in this landscape (mature Oak and Aspen forest, Black Ash swamp forest, Wet Prairie) will be important.

Lastly, the single most important site in the region for land snail diversity is Lake Itasca State Park, which harbors populations of at least 42 taxa *(78%* of regional total). The reason for this appears to be the extensive amount of old-growth forest remaining in the park, in conjunction with a diverse assemblage of habitats. While this fauna would seem well protected, the frequent use of fire management in the park is leading to the removal of the leaf litter and humus layers upon which these diverse snail assemblages depend (see below). The sites sampled within the park have all been spared fire management, and it is essential that such non-burned refuges be maintained throughout the park within all habitat types to ensure that this remarkable fauna can be conserved.

C. Appropriate management strategies.

A final comment regarding appropriate management strategies for land snail faunas must be made. Throughout the region, fire is being used as the major management tool for wet to xeric prairies, brush prairie, shrub carr, fens, aspen, oak and pine forests. The only habitats which appears to have been spared fire management are lowland forests (particularly Black Ash, Black Spruce, Tamarack, and White Cedar). Fire has long been known to have serious negative consequences on forest faunas (e.g., Stanisic 1996,. Welter-Schultes & Williams 1999, Regan *et al.* 2001). Analyses made possible due to the data collected in this study (Nekola, *in press;* manuscript included as Appendix III) also shows that fire reduces grassland land snail richness by approximately 30%, and abundance by 50-90%. Fully 72% of turf-specialist snails were negatively impacted by fire, while 67% of duff-specialists demonstrated no significant response. Frequent use of fire management thus represents a significant threat to the health and diversity of North American grassland land snail communities. Protecting of land snails in the region will require preservation of site organic litter layers, no matter if woodland or grassland sites are being considered. This goal is not possible if fire return intervals less than 15 years are used (perhaps more in some habitats). Unless management practices become more diversified, and the rate of fire decreased, serious negative impacts on the land snail fauna may be expected. It is interesting to note that such an impact may be already visible in the fauna, with a depression in richness and abundance being noted for the central Red River Valley, where some of the most intense fire management is being currently conducted.

Additionally, maintenance of old growth forest remnants is vital for land snail conservation, as these sites reliably had the highest species richness and abundance levels.

CONCLUSIONS AND RECOMMENDATIONS

Northwestern Minnesota supports a surprisingly abundant and relatively diverse land snail fauna, with 54 species being observed over the entire landscape. The Aspen Parkland landscape and lowland Black Ash forests are especially important, as up to 27 taxa may co-

occur, with densities approaching 5500 shells per 4 liters of soil litter and humus. These are among the highest densities reported in the world. While almost 50% of the fauna can be considered cosmopolitan in the region, fully 35% are restricted to, or most frequent in, the west and south of the region. These species largely represent grassland taxa, and southern species who are at the northern limit of their range. Included in this fauna are species which are quite rare elsewhere in the eastern U.S., including *Hawaiia* n.sp., *Vertigo arthuri, Vertigo cristata, Vertigo morsei, Vertigo nylanderi,* and *Vertigo paradoxa.* While the fauna appears relatively stable (based on the relatively few rare species), protection of the few remaining oldgrowth sites (such as in Lake Itasca State Park) will be essential to protection of this fauna, as these sites support the most well developed humus and leaf litter layers, and thus most diverse and abundant snail communities. Additionally, continued extensive use of fire in Prairie and Aspen Parkland communities may lead to significant reductions in both abundance and richness. Additional research (especially use of manipulative experiments on unburned sites) must be conducted to further quantify this impact, and the rate at which faunas can recover.

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TABLE 1: Distribution of sampled habitat types by county.

County	Habitat Code																						
	UF1	UF2	UF3	UF4	UF5	UF6	UF7	UF8	LF1	LF2	LF3	LF4	LF5	LF6	UG1	UG2	UG3	UG4	LG1	LG2	LG3	LG4	Total
Becker	2	1			3						2				1		1				3		13
Beltrami	1	1			3			2		1	7	2									1	1	19
Clay	2				1									1	1	3			1		3		12
Clearwater	2	1			4	1	1	2		3	2		2					1			2		21
Hubbard	1			1	2	1	2			2	1												10
Kittson	2				2					1	1									1		2	9
Lake of the Woods	1		1	1	2				1	1	3	3									1		14
Mahnomen	1		1		2		1				2				3						1		11
Marshall	1				5					2	2				1				1	1	1	1	15
Norman	1	1			1												1		1		1		6
Pennington	1				4														2		1		8
Polk		3			3			3		1	2			1	1	1			3	1	2		21
Red Lake					3				1										3				7
Roseau	1	1			2	2				1	4	1	1	1							1		15
Total	**16**	**8**	**2**	**2**	**37**	**4**	**4**	**7**	**2**	**12**	**26**	**6**	**3**	**3**	**7**	**4**	**2**	**1**	**11**	**3**	**17**	**4**	**181**

Habitat Code Legend:

Habitat	Code
Upland Forest	
Oak-Hickory	UF1
Maple-Basswood	UF2
Balsam-White Spruce	UF3
Paper Birch	UF4
Aspen	UF5
Jack Pine	UF6
Red Pine	UF7
Lakeshore	UF8
Lowland Forest	
Floodplain	LF1
Black Ash	LF2
Tamarack	LF3
White Cedar	LF4
Black Spruce	LF5
Shrub Carr	LF6

Habitat	Code
Upland Grassland	
Mesic Prairie	UG1
Xeric Prairie	UG2
Sand Prairie	UG3
Old Field	UG4
Lowland Grassland	
Wet Prairie	LG1
Sedge Meadow	LG2
Fen	LG3
Calcareous Meadow	LG4

TABLE 2: Number of occurrences and total number of individuals for all species encountered from all sites and all major habitat groups.

Species	Total		Upland Forest		Lowland Forest		Upland Grassland		Lowland Grassland	
	Occ.	Num.	Occ.	Num.	Occ.	Num.	Occ.	Num.	Occ.	Num.
Zonitoides arboreus	159	3233	79	2205	47	738	8	60	25	230
Nesovitrea electrina	153	8388	61	1546	50	3369	10	225	32	3248
Punctum minutissimum	130	10800	69	5567	35	3136	10	452	16	1645
Gastrocopta tappaniana	117	7709	34	824	44	1671	6	126	33	5088
Striatura milium	117	7527	69	5008	43	2179	1	35	4	305
Strobilops labyrinthica	110	9778	65	6221	34	2670	1	39	10	848
Euconulus fulvus	108	2231	79	1817	20	266	6	113	3	35
Nesovitrea binneyana	99	5773	68	5092	27	593	2	79	2	9
Discus catskillensis	97	4345	61	2694	30	1486			6	165
Carychium exile	91	9781	55	3933	31	5179			5	669
Cochlicopa lubricella	89	2653	54	1379	27	1059	2	59	6	156
Vallonia gracilicosta	86	8223	48	4185	17	3153	8	360	13	525
Carychium exiguum	85	16082	13	506	41	6314	3	16	28	9246
Discus cronkhitei	83	2083	28	135	30	1033	3	45	22	870
Euconulus alderi	82	3094	7	130	40	872	3	8	32	2084
Columella simplex	82	538	50	395	30	139	1	*	1	4
Hawaiia minuscula	81	2896	36	597	15	393	10	373	20	1533
Vertigo elatior	76	2865	7	21	43	604			26	2240
Vertigo arthuri	73	1005	50	764	18	181	1	*	4	60
Gastrocopta holzingeri	53	2752	33	2072	1	10	12	558	7	112
Vitrina limpida	49	813	35	666	7	111	3	18	4	18
Gastrocopta pentodon	48	1751	39	1578	8	172	1	1		
Helicodiscus parallelus	48	400	35	229	8	153	4	17	1	1
Gastrocopta contracta	47	974	28	415	9	340	1	13	9	206
Deroceras laeve	46	160	12	37	17	38	1	2	16	83
Catinella avara	43	709	10	55	10	54	6	250	17	350
Punctum n.sp.	35	2190	1	20	17	468			17	1702
Vertigo nylanderi	35	278	1	1	31	252			3	25
Vertigo milium	33	2414	3	11	1	1	5	223	24	2179
Oxyloma retusa	31	1404	1	*	5	57	2	7	23	1340
Striatura exigua	31	899	13	392	17	504			1	3
Vallonia pulchella	30	2016	9	145	5	102	5	199	11	1570
Succinea ovalis	30	593	16	211	9	349			5	33
Vertigo ovata	30	560	3	4	8	32	4	39	15	485
Cochlicopa lubrica	24	1888	8	456	13	1100			3	332
Vallonia costata	23	578	12	150	3	74	5	75	3	279
Vertigo cristata	21	227	7	164	14	63				
Vallonia perspectiva	19	634	11	499	1	2	6	62	1	71
Anguispira alternata	14	61	9	20	5	41				
Vertigo morsei	12	183							12	183
Catinella exile	11	2604			2	7			9	2597
Zonitoides nitidus	11	174	3	4	5	144			3	26
Strobilops affinis	7	527			3	37			4	490
Vertigo paradoxa	7	53	1	1	6	52				
Punctum vitreum	6	169	3	134	1	19	1	12	1	4
Gastrocopta similis	6	123			1	74	3	34	2	15
Vertigo bollesiana	4	5	3	4	1	1				
Vallonia parvula	2	66					2	66		
Pupilla muscorum	2	*	2	*						
Vertigo pygmaea	2	*	1	*			1	*		
Gastrocopta abbreviata	2	1					1	*	1	1
Hawaiia n.sp.	1	31							1	31
Catinella 'vermeta'	1	2					1	2		
Vertigo gouldi	1	1	1	1						

TABLE 3: Number of species occurrences, and percent frequency (in parentheses) for each of the major habitat groups, with Fisher's Exact Test p-values for level of significance between group.

Species	Upland Forest	Lowland Forest	Upland Grassland	Low Grassland	p-value
Anguispira alternata	9 (11.25)	5 (9.62)	0 (0.00)	0 (0.00)	0.116730
Carychium exiguum	13 (16.25)	41 (78.85)	3 (21.43)	28 (80.00)	0.000000
Carychium exile	55 (68.75)	31 (59.62)	0 (0.00)	5 (14.29)	0.000000
Catinella avara	10 (12.50)	10 (19.23)	6 (42.86)	17 (48.57)	0.000142
Catinella exile	0 (0.00)	2 (3.85)	0 (0.00)	9 (25.71)	0.000008
Catinella 'vermeta'	0 (0.00)	0 (0.00)	1 (7.14)	0 (0.00)	0.077349
Cochlicopa lubrica	8 (10.00)	13 (25.00)	0 (0.00)	3 (8.57)	0.031594
Cochlicopa lubricella	54 (67.50)	27 (51.92)	2 (14.29)	6 (17.14)	0.000000
Columella simplex	50 (62.50)	30 (57.69)	1 (7.14)	1 (2.86)	0.000000
Deroceras laeve	12 (15.00)	17 (32.69)	1 (7.14)	16 (45.71)	0.001077
Discus catskillensis	61 (76.25)	30 (57.69)	0 (0.00)	6 (17.14)	0.000000
Discus cronkhitei	28 (35.00)	30 (57.69)	3 (21.43)	22 (62.86)	0.002597
Euconulus alderi	7 (8.75)	40 (76.92)	3 (21.43)	32 (91.43)	0.000000
Euconulus fulvus	79 (98.75)	20 (38.46)	6 (42.86)	3 (8.57)	0.000000
Gastrocopta abbreviata	0 (0.00)	0 (0.00)	1 (7.14)	1 (2.86)	0.035668
Gastrocopta contracta	28 (35.00)	9 (17.31)	1 (7.14)	9 (25.71)	0.049078
Gastrocopta holzingeri	33 (41.25)	1 (1.92)	12 (85.71)	7 (20.00)	0.000000
Gastrocopta pentodon	39 (48.75)	8 (15.38)	1 (7.14)	0 (0.00)	0.000000
Gastrocopta similis	0 (0.00)	1 (1.92)	3 (21.43)	2 (5.71)	0.001043
Gastrocopta tappaniana	34 (42.50)	44 (84.62)	6 (42.86)	33 (94.29)	0.000000
Hawaiia minuscula	36 (45.00)	15 (28.85)	10 (71.43)	20 (57.14)	0.008844
Hawaiia n.sp.	0 (0.00)	0 (0.00)	0 (0.00)	1 (2.86)	0.270721
Helicodiscus parallelus	35 (43.75)	8 (15.38)	4 (28.57)	1 (2.86)	0.000003
Nesovitrea binneyana	68 (85.00)	27 (51.92)	2 (14.29)	2 (5.71)	0.000000
Nesovitrea electrina	61 (76.25)	50 (96.15)	10 (71.43)	32 (91.43)	0.002928
Oxyloma retusa	1 (1.25)	5 (9.62)	2 (14.29)	23 (65.71)	0.000000
Punctum minutissimum	69 (86.25)	35 (67.31)	10 (71.43)	16 (45.71)	0.000107
Punctum n.sp.	1 (1.25)	17 (32.69)	0 (0.00)	17 (48.57)	0.000000
Punctum vitreum	3 (3.75)	1 (1.92)	1 (7.14)	1 (2.86)	0.637781
Pupilla muscorum	2 (2.50)	0 (0.00)	0 (0.00)	0 (0.00)	0.744667
Striatura exigua	13 (16.25)	17 (32.69)	0 (0.00)	1 (2.86)	0.000642
Striatura milium	69 (86.25)	43 (82.69)	1 (7.14)	4 (11.43)	0.000000
Strobilops affinis	0 (0.00)	3 (5.77)	0 (0.00)	4 (11.43)	0.012248
Strobilops labyrinthica	65 (81.25)	34 (65.38)	1 (7.14)	10 (28.57)	0.000000
Succinea ovalis	16 (20.00)	9 (17.31)	0 (0.00)	5 (14.29)	0.319691
Vallonia costata	12 (15.00)	3 (5.77)	5 (35.71)	3 (8.57)	0.029470
Vallonia gracilicosta	48 (60.00)	17 (32.69)	8 (57.14)	13 (37.14)	0.008322
Vallonia parvula	0 (0.00)	0 (0.00)	2 (14.29)	0 (0.00)	0.005587
Vallonia perspectiva	11 (13.75)	1 (1.92)	6 (42.86)	1 (2.86)	0.000155
Vallonia pulchella	9 (11.25)	5 (9.62)	5 (35.71)	11 (31.43)	0.006217
Vertigo arthuri	50 (62.50)	18 (34.62)	1 (7.14)	4 (11.43)	0.000000
Vertigo bollesiana	3 (3.75)	1 (1.92)	0 (0.00)	0 (0.00)	0.867018
Vertigo cristata	7 (8.75)	14 (26.92)	0 (0.00)	0 (0.00)	0.000354
Vertigo elatior	7 (8.75)	43 (82.69)	0 (0.00)	26 (74.29)	0.000000
Vertigo gouldi	1 (1.25)	0 (0.00)	0 (0.00)	0 (0.00)	0.999999
Vertigo milium	3 (3.75)	1 (1.92)	5 (35.71)	24 (68.57)	0.000000
Vertigo morsei	0 (0.00)	0 (0.00)	0 (0.00)	12 (34.29)	0.000000
Vertigo nylanderi	1 (1.25)	31 (59.62)	0 (0.00)	3 (8.57)	0.000000
Vertigo ovata	3 (3.75)	8 (15.38)	4 (28.57)	15 (42.86)	0.000002
Vertigo paradoxa	1 (1.25)	6 (11.54)	0 (0.00)	0 (0.00)	0.022424
Vertigo pygmaea	1 (1.25)	0 (0.00)	1 (7.14)	0 (0.00)	0.185645
Vitrina limpida	35 (43.75)	7 (13.46)	3 (21.43)	4 (11.43)	0.000108
Zonitoides arboreus	79 (98.75)	47 (90.38)	8 (57.14)	25 (71.43)	0.000001
Zonitoides nitidus	3 (3.75)	5 (9.62)	0 (0.00)	3 (8.57)	0.420762

TABLE 4: Number of species occurrences, and percent frequency (in parentheses) for each of the major physiographic provinces, with Fisher's Exact Test p-values for level of significance between each.

Species	Prairie	Aspen Parkland	Leaf Hills	Pine Moraines	Agassiz Lowlands	p-value
Anguispira alternata	1 (2.63)	1 (2.63)	3 (20.00)	7 (13.73)	2 (5.13)	0.068261
Carychium exiguum	18 (47.37)	19 (50.00)	3 (20.00)	20 (39.22)	25 (64.10)	0.034423
Carychium exile	4 (10.53)	20 (52.63)	13 (86.67)	33 (64.71)	21 (53.85)	0.000000
Catinella avara	18 (47.37)	8 (21.05)	0 (0.00)	11 (21.57)	6 (15.38)	0.001367
Catinella exile	5 (13.16)	5 (13.16)	1 (6.67)	0 (0.00)	0 (0.00)	0.003291
Catinella 'vermeta'	1 (2.63)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.082874
Cochlicopa lubrica	2 (5.26)	7 (18.42)	2 (13.33)	4 (7.84)	9 (23.08)	0.101364
Cochlicopa lubricella	9 (23.68)	24 (63.16)	7 (46.67)	26 (50.98)	23 (58.97)	0.005030
Columella simplex	2 (5.26)	10 (26.32)	8 (53.33)	37 (72.55)	25 (64.10)	0.000000
Deroceras laeve	16 (42.11)	11 (28.95)	4 (26.67)	5 (9.80)	10 (25.64)	0.010032
Discus catskillensis	8 (21.05)	19 (50.00)	13 (86.67)	30 (58.82)	27 (69.23)	0.000010
Discus cronkhitei	21 (55.26)	18 (47.37)	7 (46.67)	16 (31.37)	21 (53.85)	0.146482
Euconulus alderi	18 (47.37)	19 (50.00)	4 (26.67)	19 (37.25)	22 (56.41)	0.222375
Euconulus fulvus	14 (36.84)	25 (65.79)	12 (80.00)	36 (70.59)	21 (53.85)	0.006493
Gastrocopta abbreviata	1 (2.63)	0 (0.00)	0 (0.00)	1 (1.96)	0 (0.00)	0.877966
Gastrocopta contracta	12 (31.58)	14 (36.84)	10 (66.67)	11 (21.57)	0 (0.00)	0.000000
Gastrocopta holzingeri	21 (55.26)	16 (42.11)	6 (40.00)	8 (15.69)	2 (5.13)	0.000001
Gastrocopta pentodon	3 (7.89)	14 (36.84)	9 (60.00)	20 (39.22)	2 (5.13)	0.000001
Gastrocopta similis	5 (13.16)	1 (2.63)	0 (0.00)	0 (0.00)	0 (0.00)	0.005340
Gastrocopta tappaniana	27 (71.05)	29 (76.32)	5 (33.33)	24 (47.06)	32 (82.05)	0.000273
Hawaiia minuscula	29 (76.32)	25 (65.79)	8 (53.33)	14 (27.45)	5 (12.82)	0.000000
Hawaiia n.sp.	1 (2.63)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.082874
Helicodiscus parallelus	6 (15.79)	6 (15.79)	7 (46.67)	27 (52.94)	2 (5.13)	0.000000
Nesovitrea binneyana	6 (15.79)	20 (52.63)	12 (80.00)	36 (70.59)	25 (64.10)	0.000000
Nesovitrea electrina	31 (81.58)	34 (89.47)	13 (86.67)	40 (78.43)	35 (89.74)	0.550183
Oxyloma retusa	15 (39.47)	7 (18.42)	1 (6.67)	6 (11.76)	2 (5.13)	0.001243
Punctum minutissimum	23 (60.53)	30 (78.95)	10 (66.67)	36 (70.59)	31 (79.49)	0.323127
Punctum n.sp.	7 (18.42)	10 (26.32)	1 (6.67)	8 (15.69)	9 (23.08)	0.500538
Punctum vitreum	2 (5.26)	0 (0.00)	2 (13.33)	2 (3.92)	0 (0.00)	0.077154
Pupilla muscorum	0 (0.00)	0 (0.00)	0 (0.00)	2 (3.92)	0 (0.00)	0.369393
Striatura exigua	0 (0.00)	0 (0.00)	5 (33.33)	20 (39.22)	6 (15.38)	0.000000
Striatura milium	4 (10.53)	22 (57.89)	14 (93.33)	42 (82.35)	35 (89.74)	0.000000
Strobilops affinis	3 (7.89)	2 (5.26)	0 (0.00)	2 (3.92)	0 (0.00)	0.472614
Strobilops labyrinthica	8 (21.05)	23 (60.53)	13 (86.67)	40 (78.43)	26 (66.67)	0.000000
Succinea ovalis	4 (10.53)	10 (26.32)	1 (6.67)	2 (3.92)	13 (33.33)	0.000771
Vallonia costata	9 (23.68)	4 (10.53)	3 (20.00)	5 (9.80)	2 (5.13)	0.114534
Vallonia gracilicosta	23 (60.53)	25 (65.79)	9 (60.00)	17 (33.33)	12 (30.77)	0.001737
Vallonia parvula	2 (5.26)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.198662
Vallonia perspectiva	11 (28.95)	3 (7.89)	3 (20.00)	2 (3.92)	0 (0.00)	0.000115
Vallonia pulchella	12 (31.58)	6 (15.79)	3 (20.00)	8 (15.69)	1 (2.56)	0.010705
Vertigo arthuri	6 (15.79)	20 (52.63)	6 (40.00)	25 (49.02)	16 (41.03)	0.006013
Vertigo bollesiana	0 (0.00)	0 (0.00)	0 (0.00)	4 (7.84)	0 (0.00)	0.055137
Vertigo cristata	0 (0.00)	0 (0.00)	2 (13.33)	9 (17.65)	10 (25.64)	0.000091
Vertigo elatior	9 (23.68)	21 (55.26)	3 (20.00)	20 (39.22)	23 (58.97)	0.003255
Vertigo gouldi	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.96)	0 (0.00)	1.000000
Vertigo milium	20 (52.63)	10 (26.32)	1 (6.67)	2 (3.92)	0 (0.00)	0.000000
Vertigo morsei	6 (15.79)	3 (7.89)	1 (6.67)	2 (3.92)	0 (0.00)	0.056922
Vertigo nylanderi	0 (0.00)	2 (5.26)	1 (6.67)	15 (29.41)	17 (43.59)	0.000000
Vertigo ovata	8 (21.05)	10 (26.32)	1 (6.67)	7 (13.73)	4 (10.26)	0.264460
Vertigo paradoxa	0 (0.00)	0 (0.00)	0 (0.00)	3 (5.88)	4 (10.26)	0.079448
Vertigo pygmaea	0 (0.00)	0 (0.00)	0 (0.00)	2 (3.92)	0 (0.00)	0.369393
Vitrina limpida	6 (15.79)	22 (57.89)	3 (20.00)	11 (21.57)	7 (17.95)	0.000248
Zonitoides arboreus	28 (73.68)	37 (97.37)	14 (93.33)	46 (90.20)	34 (87.18)	0.033832
Zonitoides nitidus	2 (5.26)	1 (2.63)	2 (13.33)	4 (7.84)	2 (5.13)	0.587492

TABLE 5a: Number of occurrences and total number of individuals of each species observed per county

Species	County													
	Becker		Beltrami		Clay		Clearwater		Hubbard		Kittson		Lake of the Woods	
	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num
Anguispira alternata	2	2	1	*			4	15			1	27	1	11
Carychium exiguum	6	1747	13	2138	5	1687	8	832	3	112	5	990	6	437
Carychium exile	8	473	8	608	2	35	13	1084	7	436	6	1910	9	544
Catinella avara	4	48	4	8	2	36	6	89			2	25	3	26
Catinella exile	2	947			2	829					2	7		
Catinella 'vermeta'					1	2								
Cochlicopa lubrica			1	6	1	7	3	143	1	38	3	1113	5	161
Cochlicopa lubricella	7	248	8	118	2	6	11	377	5	209	7	207	10	239
Columella simplex	6	61	13	55	1	4	15	115	9	88	1	1	10	60
Deroceras laeve	3	38	5	20	4	12	3	5			5	10	5	7
Discus catskillensis	6	321	10	270	5	85	11	602	7	254	5	386	11	404
Discus cronkhitei	6	180	8	43	7	251	9	28	2	44	4	502	7	73
Euconulus alderi	6	361	10	167	6	451	9	139	2	18	5	224	4	31
Euconulus fulvus	7	175	11	142	5	92	13	264	10	137	7	151	10	162
Gastrocopta abbreviata							1	*						
Gastrocopta contracta	5	76	2	18	6	85	5	70	1	91	5	285		
Gastrocopta holzingeri	4	297	2		5	407	4	466			5	34		
Gastrocopta pentodon	7	247	3	37	1	2	8	156	3	61	4	275		
Gastrocopta similis					2	13					1	9		
Gastrocopta tappaniana	6	921	15	389	8	1220	12	206	2	95	9	656	12	288
Hawaiia minuscula	8	489	2	5	8	208	8	465	1	61	7	382	2	18
Hawaiia n.sp.					1	31								
Helicodiscus parallelus	8	60	5	113			12	64	4	38	1	4	2	9
Nesovitrea binneyana	7	468	10	234	4	258	14	746	9	415	7	304	12	454
Nesovitrea electrina	11	667	16	582	11	899	17	508	9	357	9	1052	13	252
Oxyloma retusa	5	629	2	13	5	73	3	29					2	11
Punctum minutissimum	6	450	13	357	7	243	16	1108	7	437	9	1471	11	537
Punctum n.sp.	3	246	4	64	4	589	3	54	1	7	3	115	2	40
Punctum vitreum	4	90			1	19								
Pupilla muscorum			1	*			1	*						
Striatura exigua	1	9	6	245			9	345	5	142			3	37
Striatura milium	8	642	16	527	2	53	17	979	9	742	5	201	12	612
Strobilops affinis	1	26			2	31	1	1						

TABLE 5a: continued.

Species	County													
	Becker		Beltrami		Clay		Clearwater		Hubbard		Kittson		Lake of the Woods	
	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num
Strobilops labyrinthica	10	1077	11	715	3	186	16	1265	9	635	5	202	10	539
Succinea ovalis	2	20	1	*	2	23					2	48	5	67
Vallonia costata	2	32	2	*	1	1	2	*	1	1	1	10		
Vallonia gracilicosta	6	743	6	19	8	211	7	259			8	959	6	572
Vallonia parvula					1	44								
Vallonia perspectiva	1	36	1	*	4	72	1	89			2	50		
Vallonia pulchella	4	129	3	284	1	2	4	28			1	12		
Vertigo arthuri	5	63	6	34	1	42	11	71	4	23	5	55	7	50
Vertigo bollesiana			3	4			1	1						
Vertigo cristata	1	12	2	6			4	114	3	33			4	35
Vertigo elatior	4	419	13	248	4	178	9	108	2	15	6	265	4	82
Vertigo gouldi							1	1						
Vertigo milium	4	353			5	374	1	5			1	7		
Vertigo morsei	3	22	1	93	2	21	1	3						
Vertigo nylanderi	2	4	8	53			7	54	2	23			3	54
Vertigo ovata	3	28	6	59	2	9	3	102			4	57	1	3
Vertigo paradoxa			2	5			1	1	1	1			3	46
Vertigo pygmaea							2	*						
Vitrina limpida	4	75	1	*	3	48	5	35	2	16	7	190	2	41
Zonitoides arboreus	11	397	16	226	10	209	18	445	10	236	9	192	11	75
Zonitoides nitidus	1	16	1	*			2	93	1	2	1	4	1	3
Richness	43		43		42		47		30		38		34	

TABLE 5b: Number of occurrences and total number of individuals of each species observed per county

Species	County													
	Mahnomen		Marshall		Norman		Pennington		Polk		Red Lake		Roseau	
	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num
Anguispira alternata	1	2	1	1	1	1			2	2				
Carychium exiguum	3	798	10	2610	4	879	2	694	8	1855	3	225	9	1078
Carychium exile	7	305	6	1757	2	145	4	431	8	700	3	352	8	1001
Catinella avara	2	166	3	41	3	19	2	56	7	59	3	126	2	10
Catinella exile	1	173	1	271	1	273	1	85	1	19				
Catinella 'vermeta'														
Cochlicopa lubrica			1	8	1	4	3	118	1	253	1	10	3	27
Cochlicopa lubricella	2	39	11	539	3	64	5	82	7	179	4	119	7	227
Columella simplex	5	30	2	26	1	1	3	10	5	13	2	12	9	62
Deroceras laeve	2	2	2	2	4	30	1	1	7	25	3	3	2	5
Discus catskillensis	6	188	10	611	1	11	4	179	8	211	3	86	10	737
Discus cronkhitei	6	273	7	345	3	139	5	97	9	43	4	37	6	28
Euconulus alderi	3	121	8	384	2	220	6	369	8	342	3	127	10	140
Euconulus fulvus	8	139	9	337	3	84	4	107	9	106	5	125	7	210
Gastrocopta abbreviata									1	1				
Gastrocopta contracta	3	14	1	40	3	72	4	84	9	113	2	18	1	8
Gastrocopta holzingeri	5	178	6	182	4	761	4	156	8	169	3	91	3	11
Gastrocopta pentodon	4	31	5	251	2	29	2	270	5	126	2	198	2	68
Gastrocopta similis	1	21							1	74	1	6		
Gastrocopta tappaniana	5	394	11	933	4	498	5	546	12	864	5	423	11	276
Hawaiia minuscula	6	384	8	151	5	259	5	90	12	193	6	184	3	7
Hawaiia n.sp.														
Helicodiscus parallelus	5	22	3	14	2	12			5	58	1	6		
Nesovitrea binneyana	6	146	7	707	3	136	3	265	6	559	3	404	8	677
Nesovitrea electrina	9	543	13	1085	3	365	7	528	15	825	7	191	13	534
Oxyloma retusa	2	51	2	54	2	106	1	4	5	423	2	11		
Punctum minutissimum	8	476	12	1661	3	909	6	867	15	572	5	908	12	804
Punctum n.sp.	2	95	3	300	1	155	1	360	3	73	1	6	4	86
Punctum vitreum	1	60												
Pupilla muscorum														
Striatura exigua	2	72	2	29					2	15			1	5
Striatura milium	6	268	12	1460	2	22	5	330	8	213	2	345	13	1133
Strobilops affinis	1	361							2	108				

TABLE 5a: continued.

Species	County													
	Mahnomen		Marshall		Norman		Pennington		Polk		Red Lake		Roseau	
	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num	Occ	Num
Strobilops labyrinthica	6	443	10	1706	4	335	5	292	8	552	3	414	10	1417
Succinea ovalis			9	235	1	10	1	3			3	130	4	57
Vallonia costata	2	65	1	190	1	57			5	26	3	187	2	9
Vallonia gracilicosta	7	191	10	2234	2	474	6	642	10	1498	5	196	5	225
Vallonia parvula									1	22				
Vallonia perspectiva	3	25	2	173	2	116			3	73				
Vallonia pulchella	2	163			2	728	2	108	8	406	2	155	1	1
Vertigo arthuri	5	21	6	115	1	17	5	246	6	94	4	58	7	116
Vertigo bollesiana														
Vertigo cristata	1	2	2	4					1	2			3	19
Vertigo elatior	3	53	9	642	1	45	2	79	6	524	3	88	10	119
Vertigo gouldi														
Vertigo milium	2	267	4	595	3	140	3	157	7	393	3	123		
Vertigo morsei	1	20			1	5	1	8	2	11				
Vertigo nylanderi	1	7	3	32					2	5			7	46
Vertigo ovata	1	30	2	6	1	112	1	6	4	134	1	5	1	9
Vertigo paradoxa														
Vertigo pygmaea														
Vitrina limpida	2	115	6	71	1	4	5	58	5	84	1	42	5	34
Zonitoides arboreus	10	335	14	345	5	127	8	130	16	312	7	57	14	147
Zonitoides nitidus									3	2			1	54
Richness	42		39		38		34		45		35		35	

FIGURE LEGENDS

Figure 1: Map of study region, showing location and major habitat affinities of the 181 sample sites.

Figure 2: Box plot of site richness by habitat type, with ANOVA summary statistics.

Figure 3: Box plot of site richness by major habitat groups, with ANOVA summary statistics.

Figure 4: Box plot of snail abundance per sample by habitat type, with ANOVA summary statistics.

Figure 5: Box plot of snail abundance per sample by major habitat groups, with ANOVA summary statistics.

Figure 6: Box plot of site richness by county, with ANOVA summary statistics.

Figure 7: Box plot of site richness by physiographic provinces, with ANOVA summary statistics.

Figure 8: Geographic variation in site richness as estimated through block kriging.

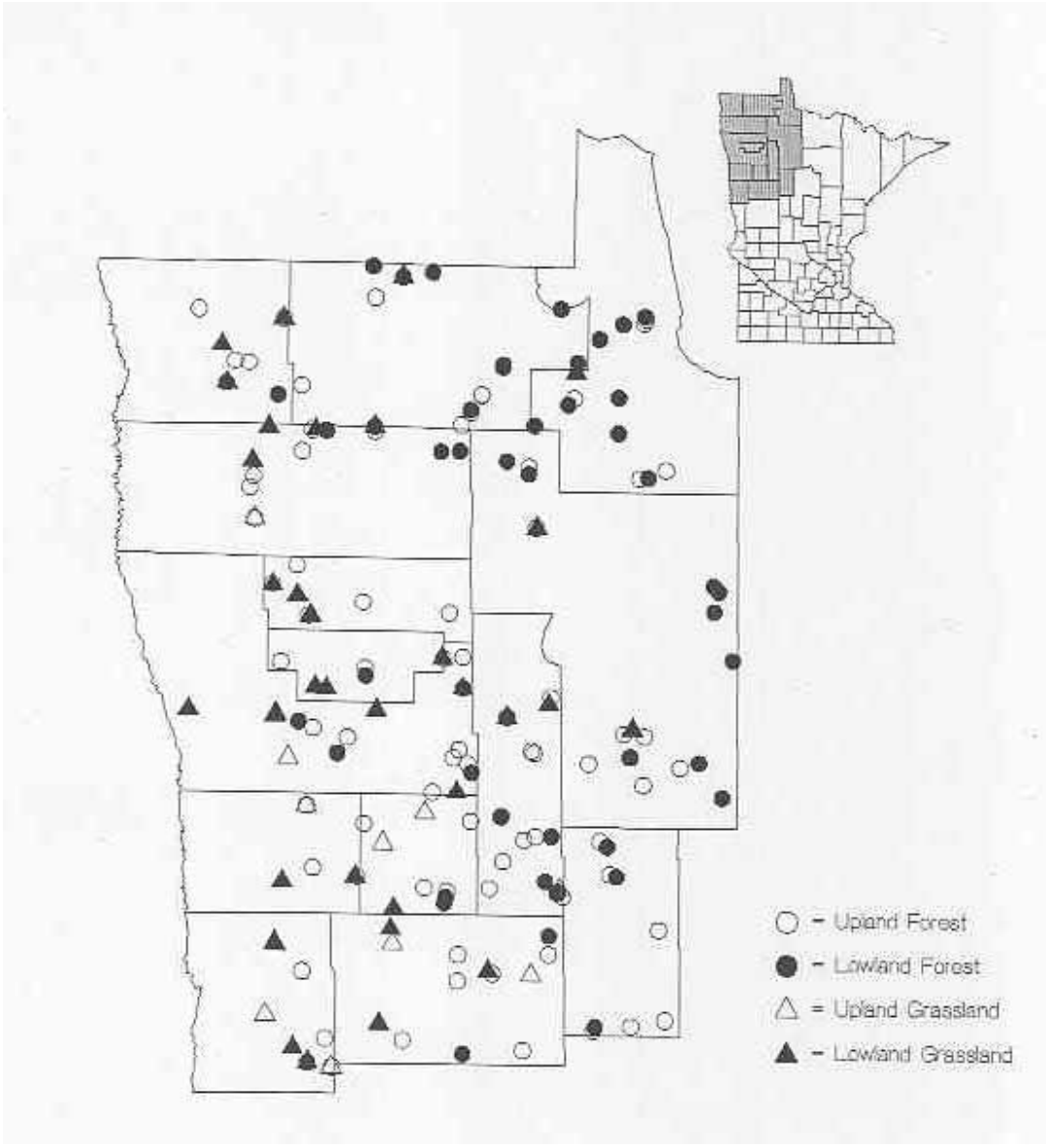
Figure 9: Box plot of snail abundance per sample by county, with ANOVA summary statistics.

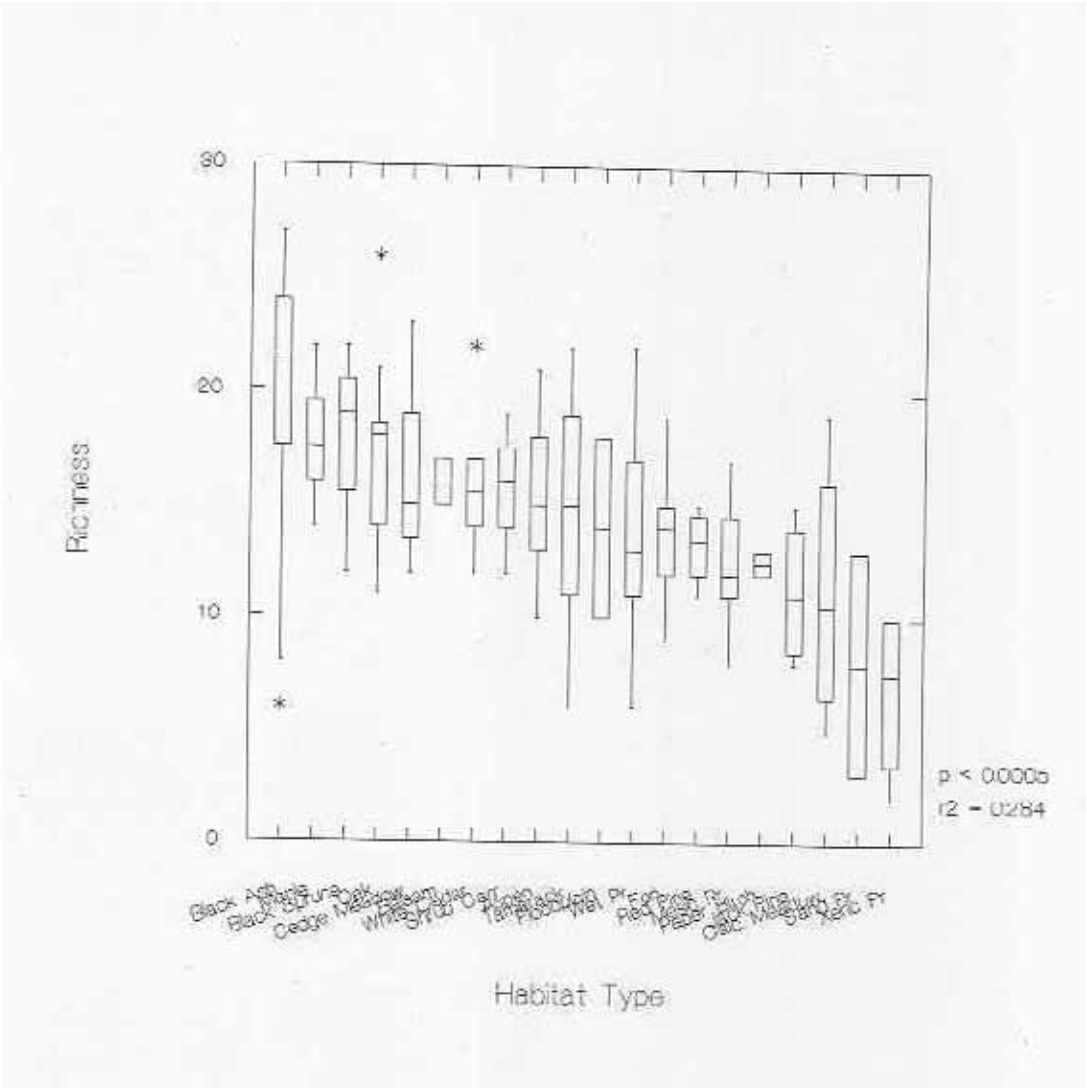
Figure 10: Box plot of snail abundance per sample by physiographic provinces, with ANOVA summary statistics.

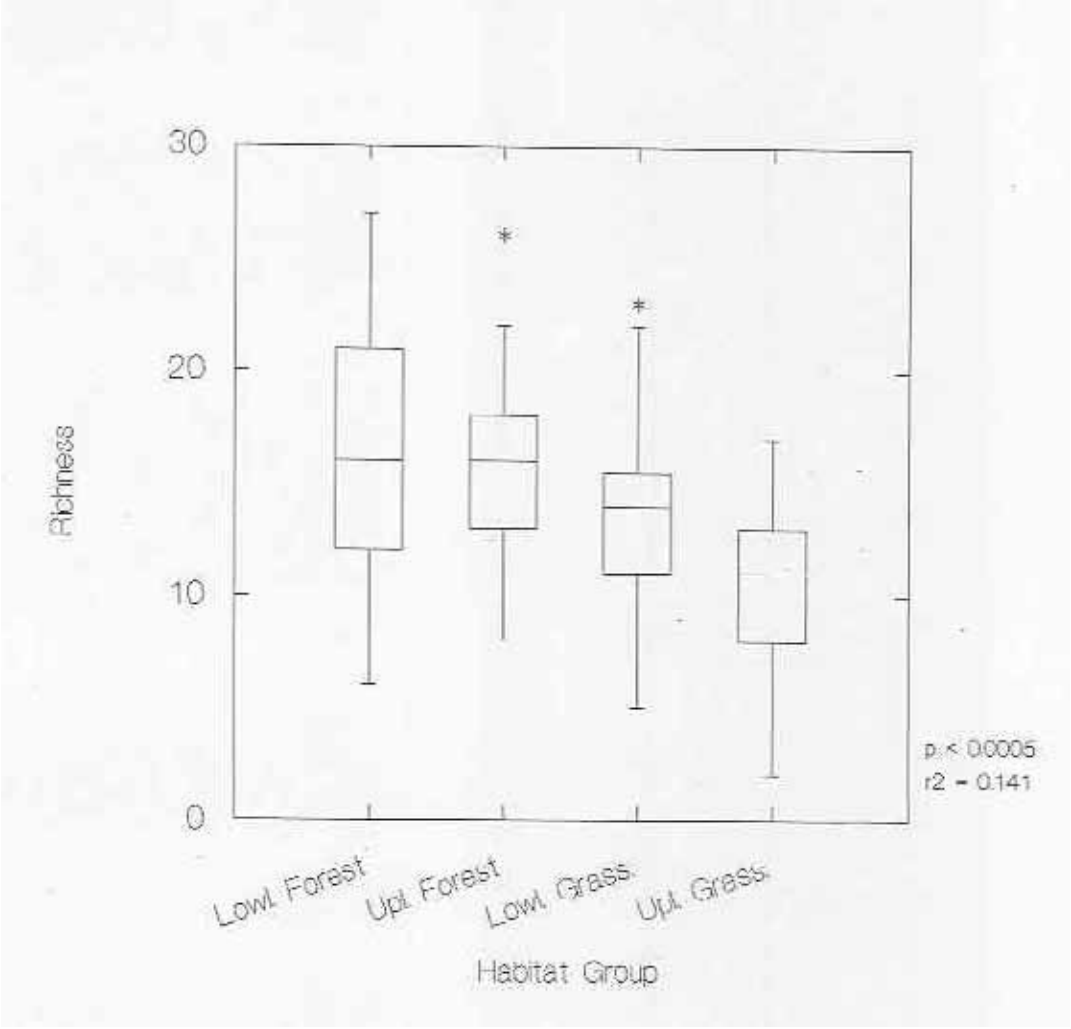
Figure 11. Geographic variation in snail abundance per sample as estimated through block kriging.

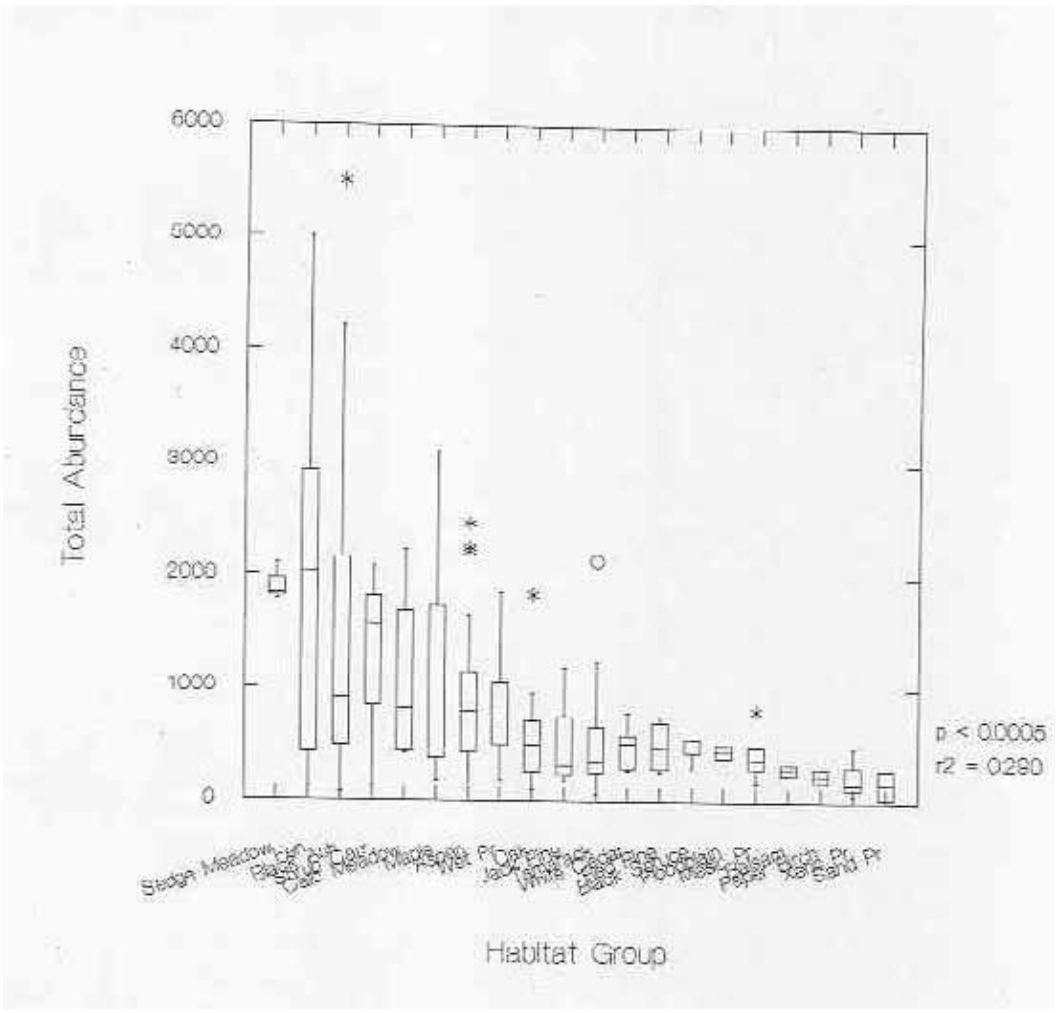
Figure 12: Scatterplot diagrams demonstrating the richness-abundance curves for raw and semi-log transformed data. The best-fit line for the raw data was determined through Locally Weighted Scatterplot Smoothing, while the best-fit line for transformed data was determined through linear regression. Summary statistics for this line are provided.

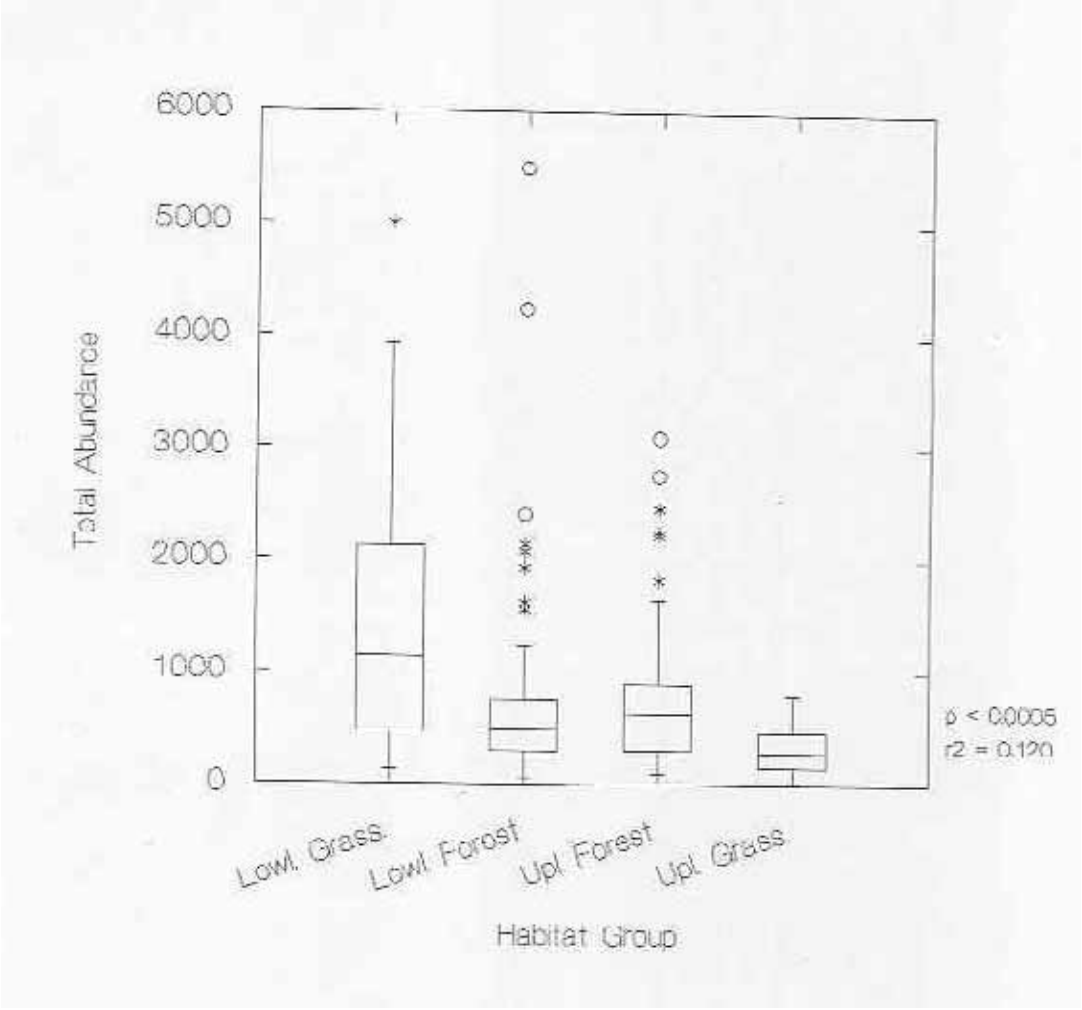
Figure 13. Dominance-diversity curves for the entire dataset and for each of the major habitat groups.

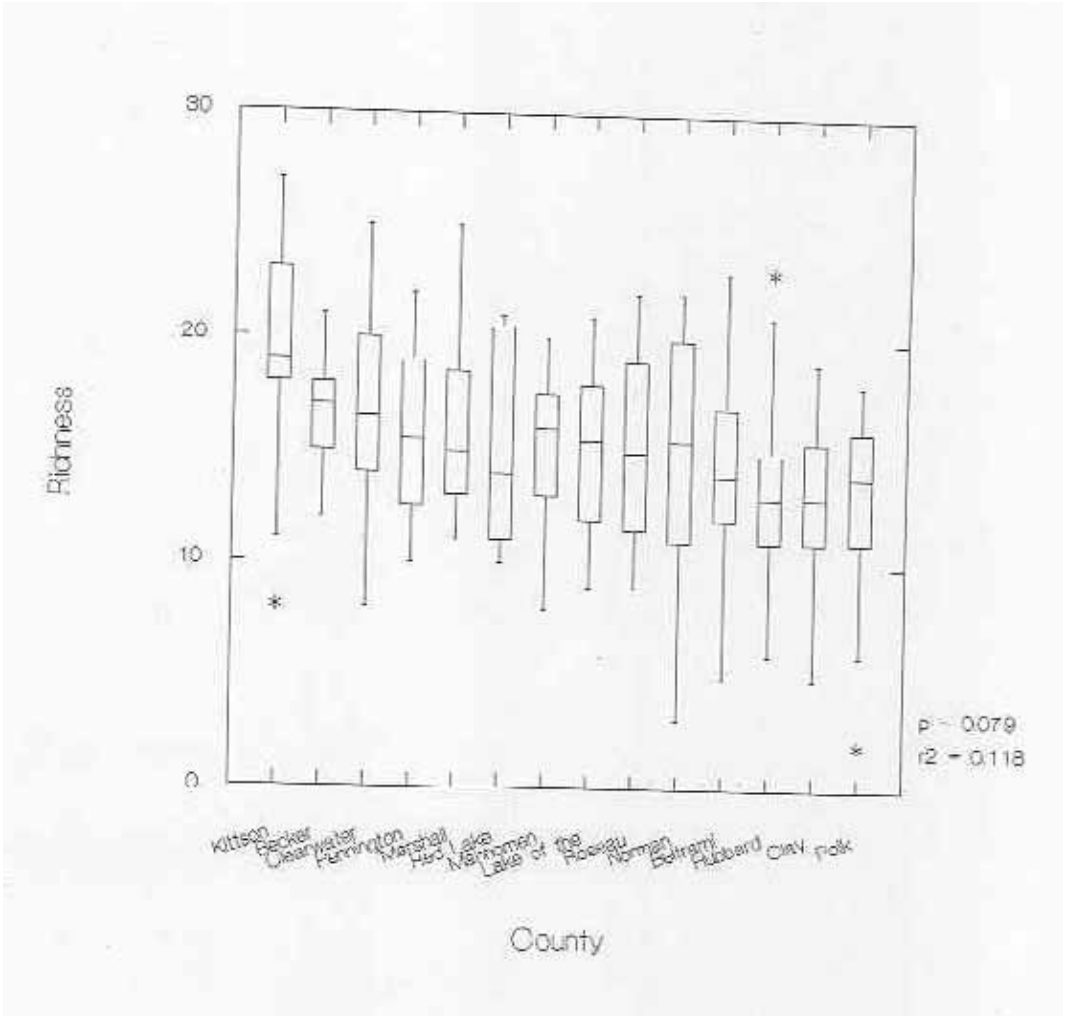

○ - Upland Forest
● - Lowland Forest
△ = Upland Grassland
▲ - Lowland Grassland

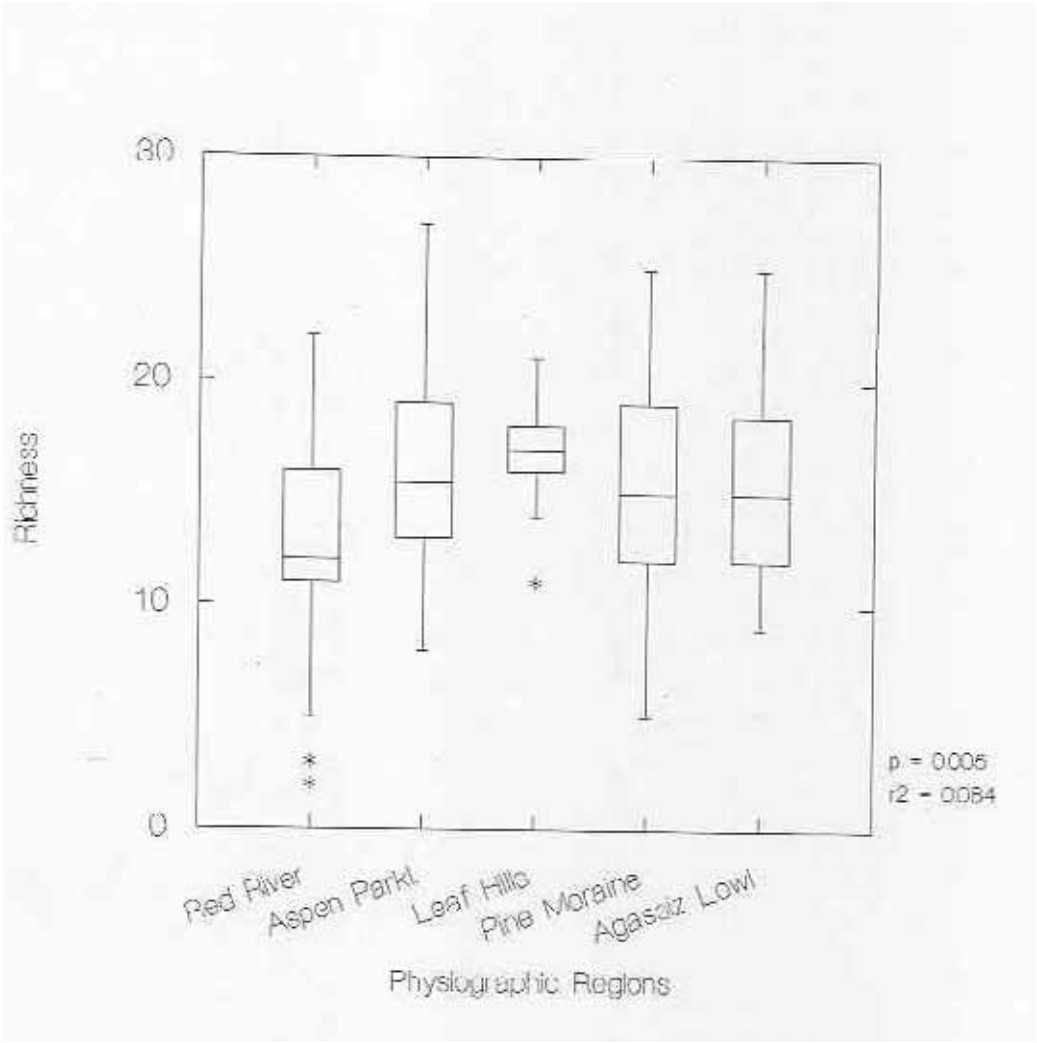

30
20
10
0
Richness
p < 0.0005
r2 = 0.284
Habitat Type

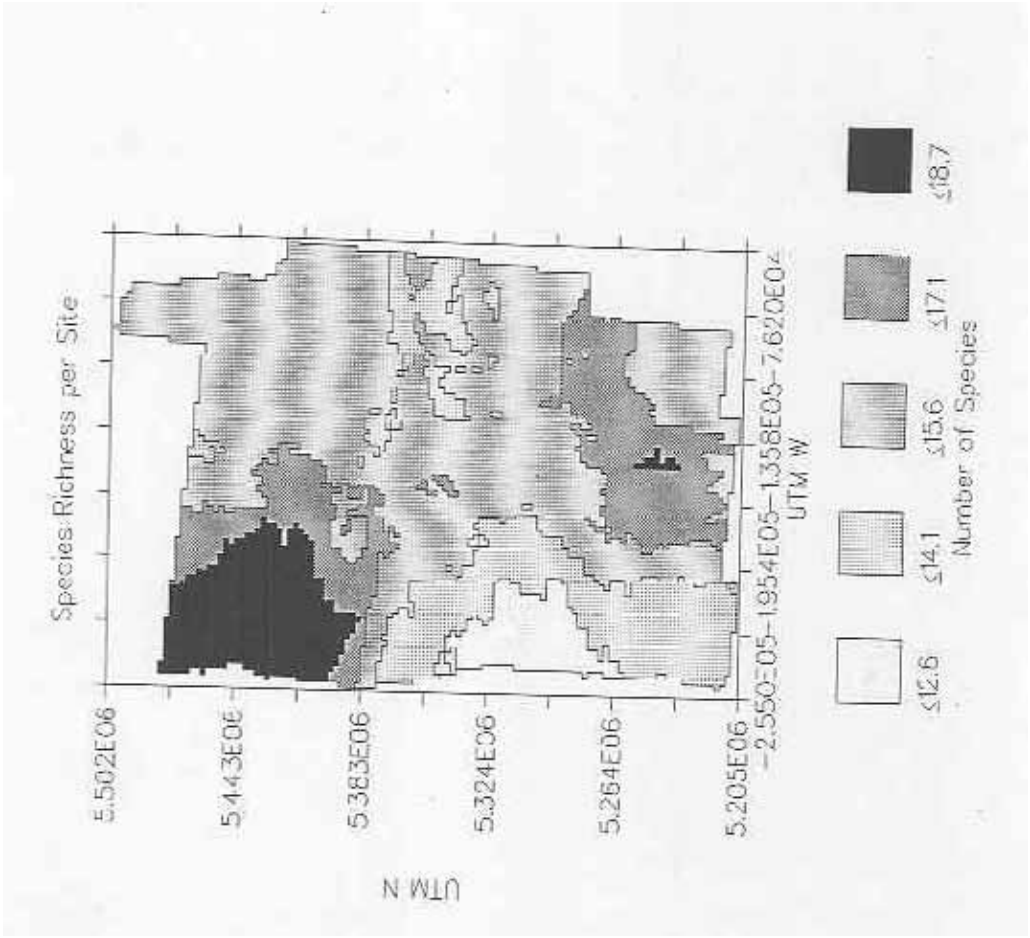

30
20
10
0
Richness
Lowl. Forest
Upl. Forest
Lowl. Grass
Upl. Grass
Habitat Group
p < 0.0005
r2 = 0.141

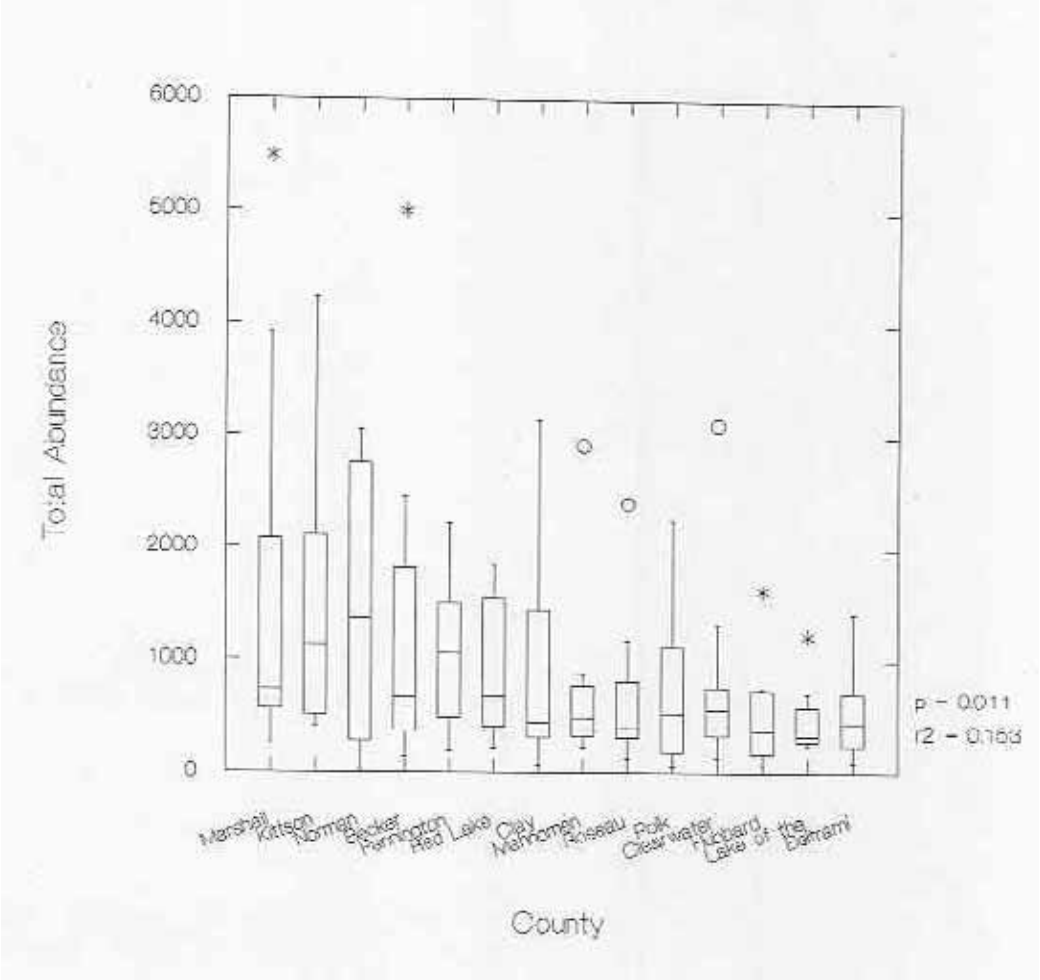

6000
5000
4000
3000
2000
1000
0
Total Abundance
p < 0.0005
r2 = 0.290
Habitat Group

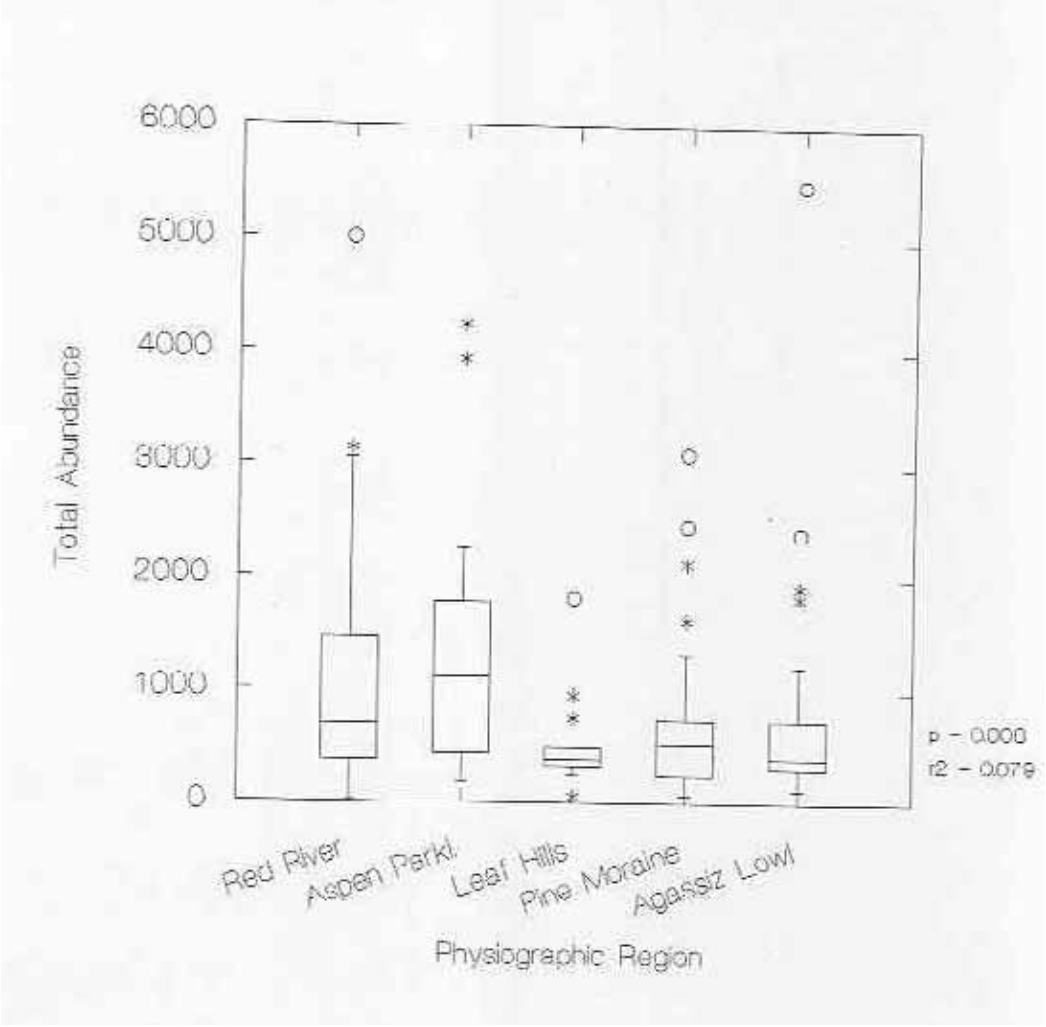

6000
5000
4000
3000
2000
1000
0
Total Abundance
Low. Grass
Low. Forest
Upl. Forest
Upl. Grass
Habitat Group
p < 0.0005
r2 = 0.120

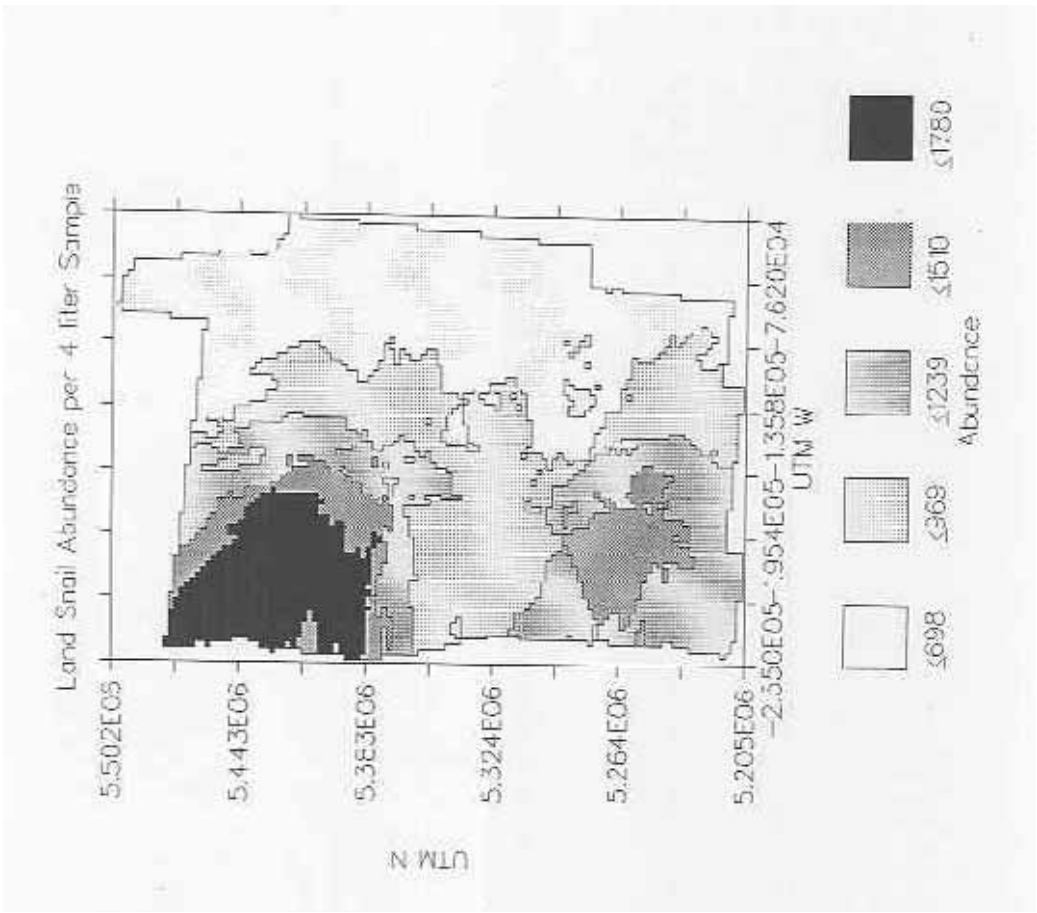

30
20
10
0
Richness
p = 0.079
r2 = 0.118
Kittson
Becker
Clearwater
Pennington
Marshall
Red Lake
Mahnomen
Lake of the Woods
Roseau
Norman
Beltrami
Hubbard
Clay
Polk
County


30
20
10
0
Richness
p = 0.005
r2 = 0.084
Red River
Aspen Parkl
Leaf Hills
Pine Moraine
Agassiz Lowl
Physiographic Regions

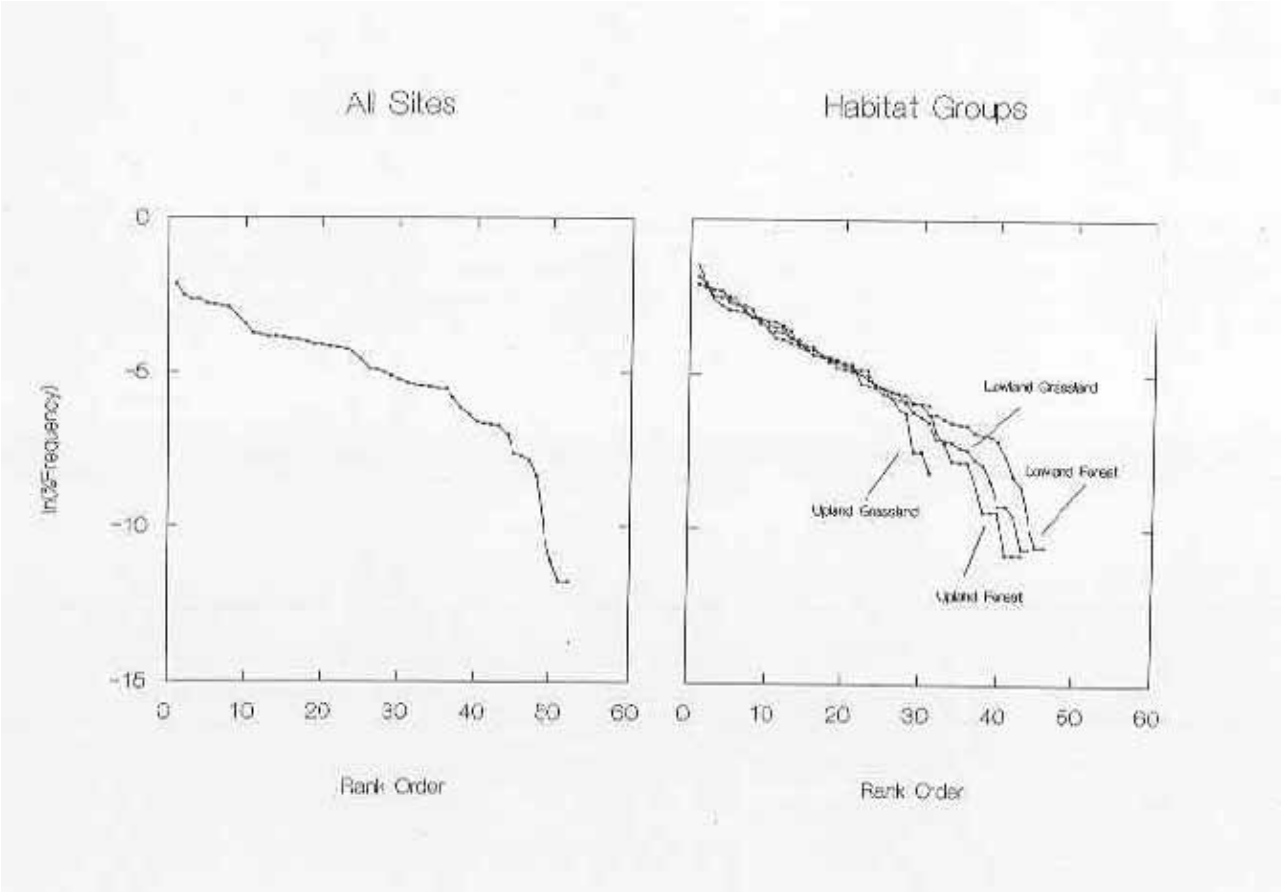

Species Richness per Site
UTM N
5.502E06
5.443E06
5.383E06
5.324E06
5.264E06
5.205E06
-2.550E05
-1.954E05
-1.358E05
-7.620E04
UTM W
≤12.6
≤14.1
≤15.6
≤17.1
≤18.7
Number of Species


6000
5000
4000
3000
2000
1000
0
Total Abundance
p = 0.011
r2 = 0.153
Marshall
Kittson
Norman
Becker
Pennington
Red Lake
Clay
Mahnomen
Roseau
Polk
Clearwater
Hubbard
Lake of the Woods
County


6000
5000
4000
3000
2000
1000
0
Total Abundance
p = 0.000
r2 = 0.078
Red River
Aspen Park
Lear Hills
Pine Moraine
Agassiz Lowl
Physiographic Region

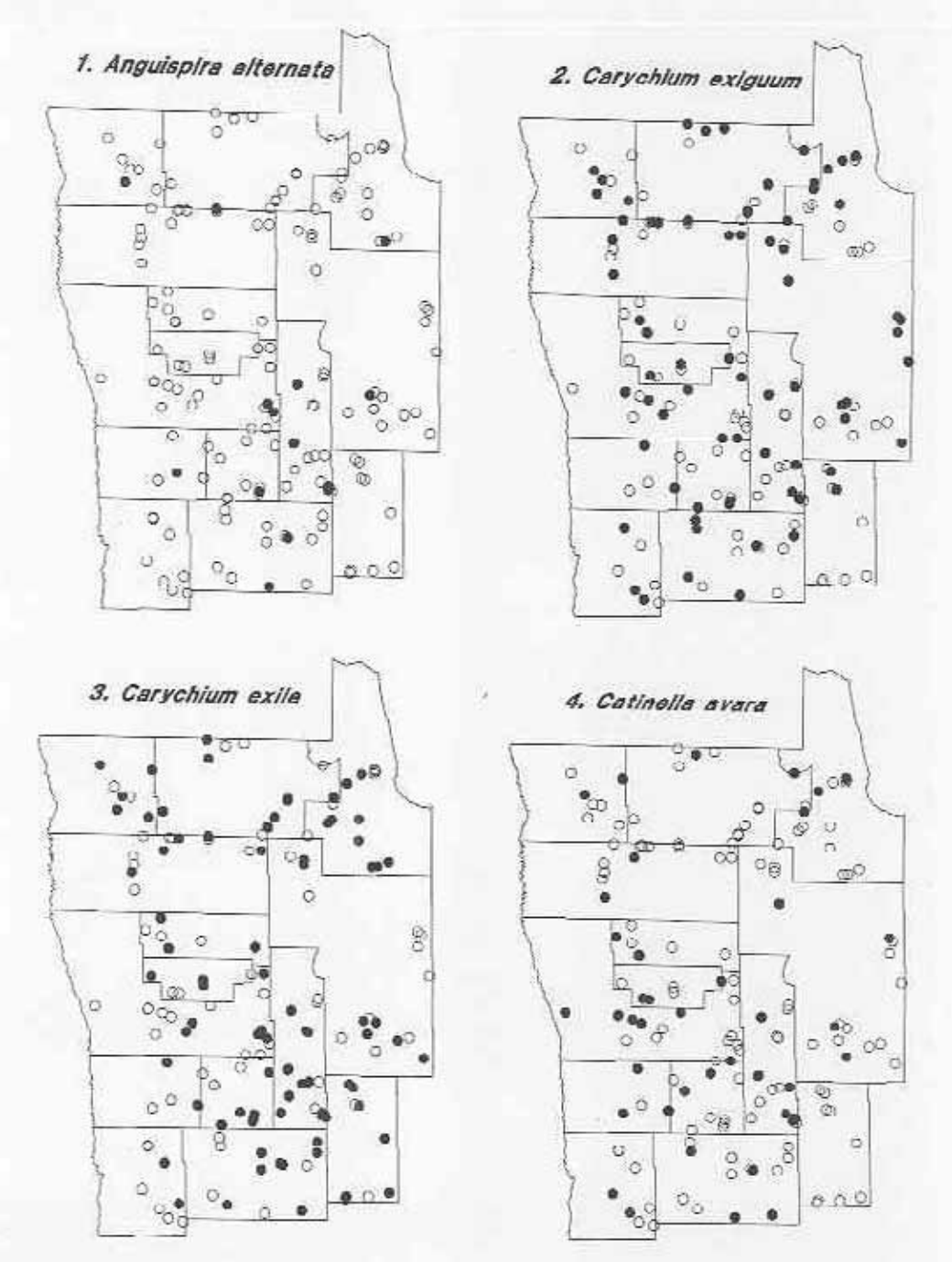

Land Snail Abundance per 4 filter Sample
5.502E06
5.443E06
5.383E06
5.324E06
5.264E06
5.205E06
UTM N
-2.350E05
-1.954E05
-1.358E05
-7.620E04
UTM W
≤698
≤969
≤1239
≤1510
≤1780
Abundance

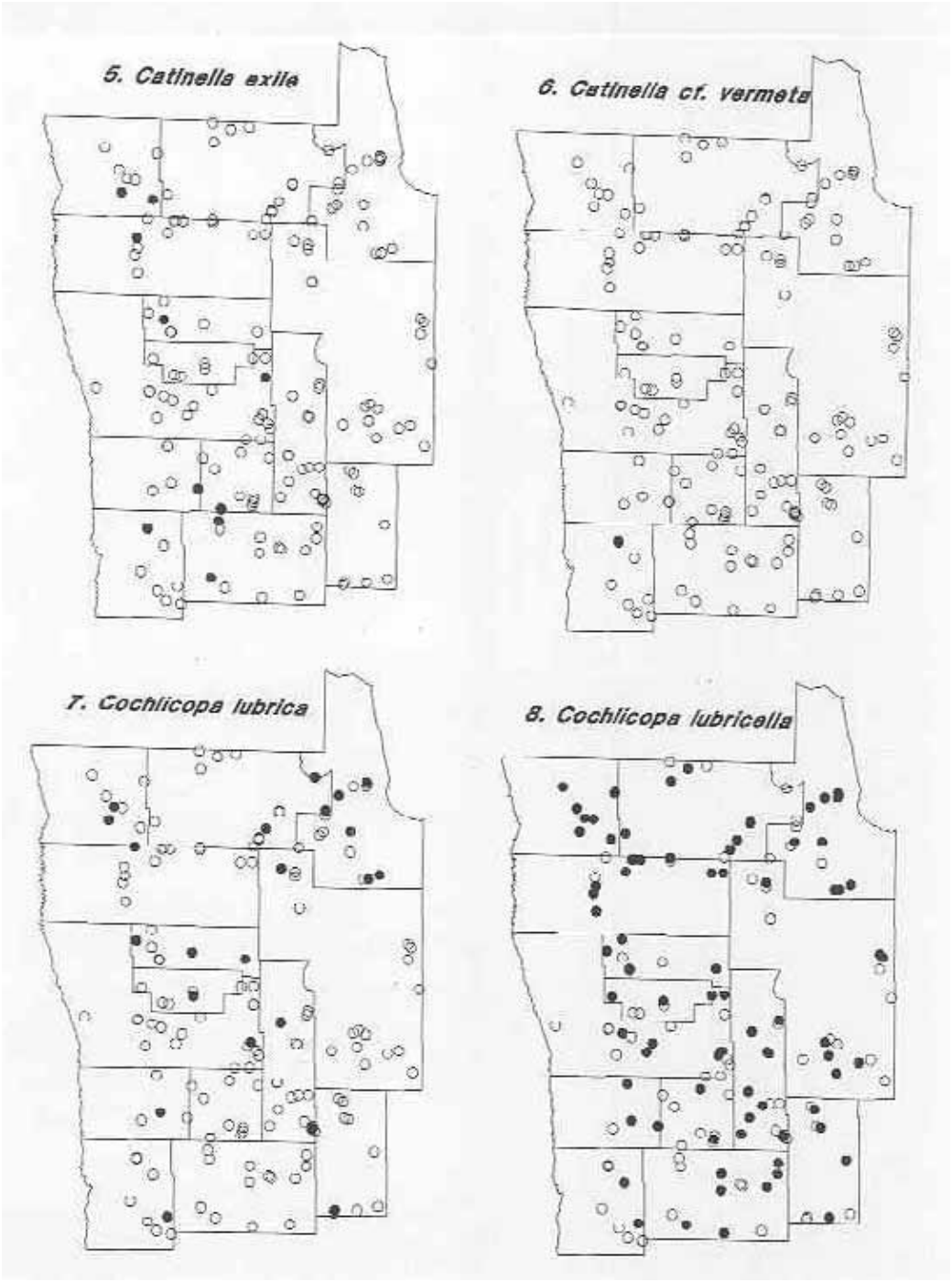
Raw Data
Transformed Data
Richness
Total Abundance
ln(Total Abundance)
p < 0.0005
r2 = 0.328
30
20
10
0
-10
0
1000
2000
3000
4000
5000
6000
2
4
6
8
10

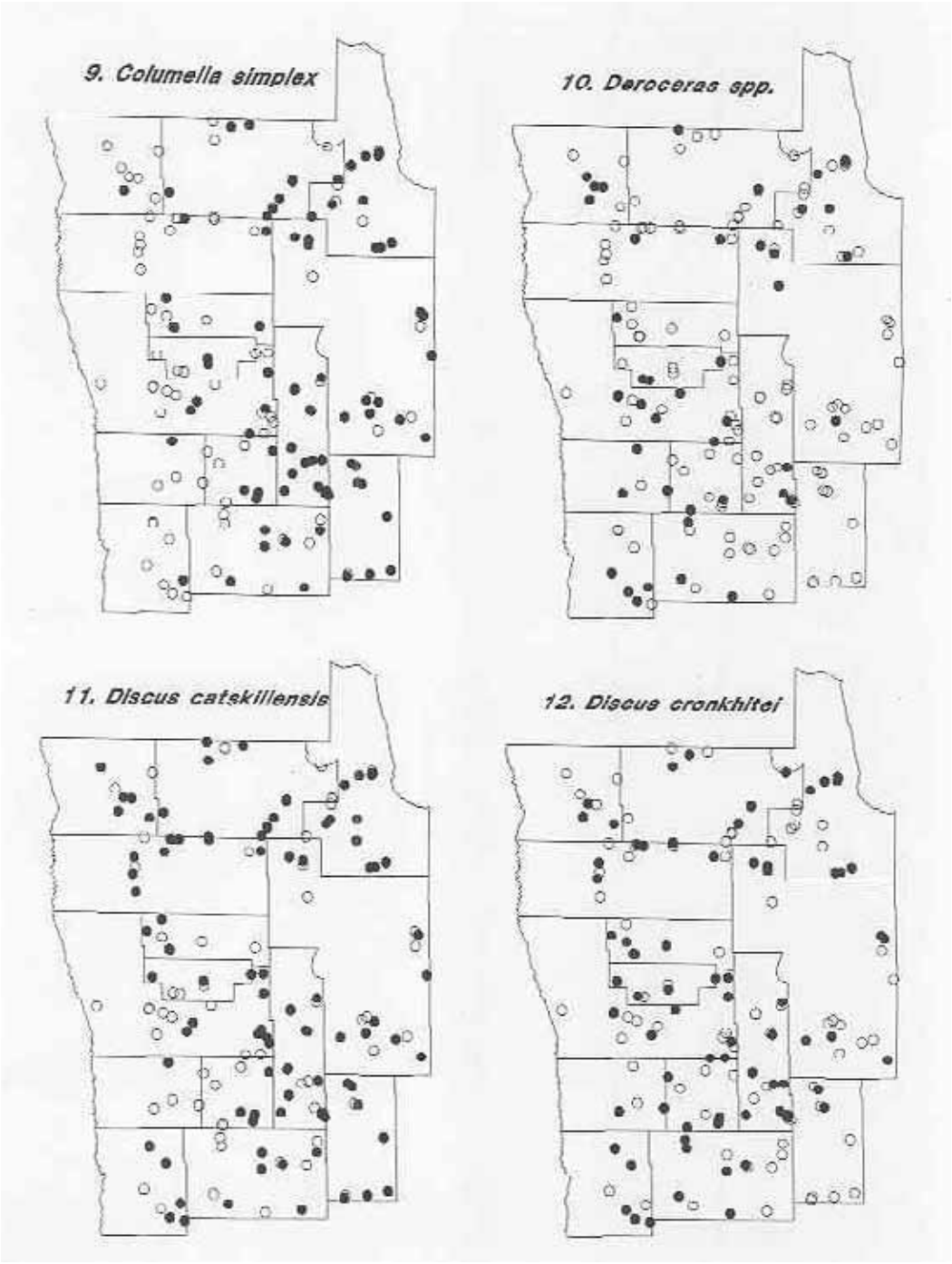

All Sites
Habitat Groups
ln(%Frequency)
0
-5
-10
-15
0
10
20
30
40
50
60
Rank Order
Lowland Grassland
Lowland Forest
Upland Grassland
Upland Forest

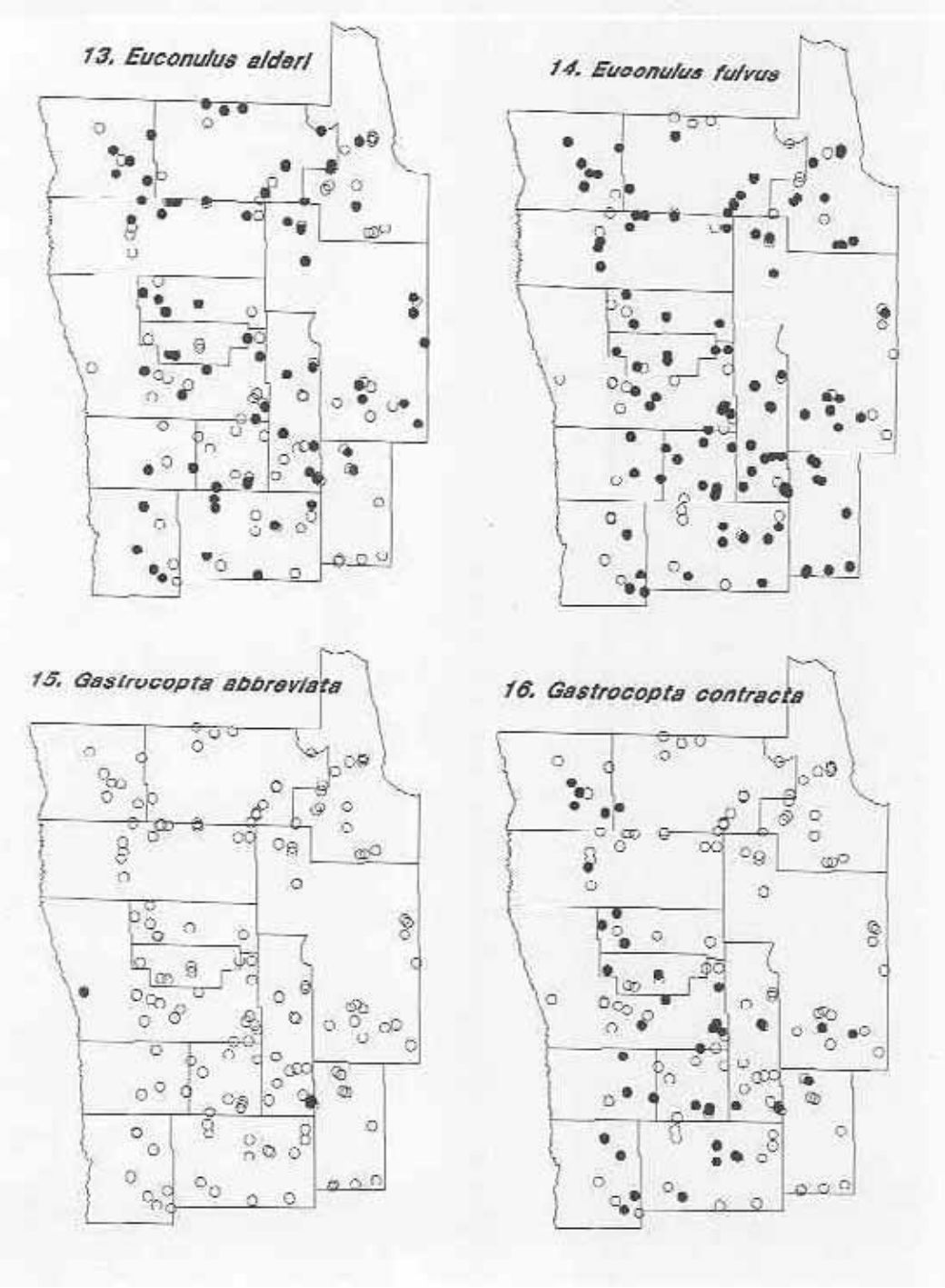
APPENDIX I:

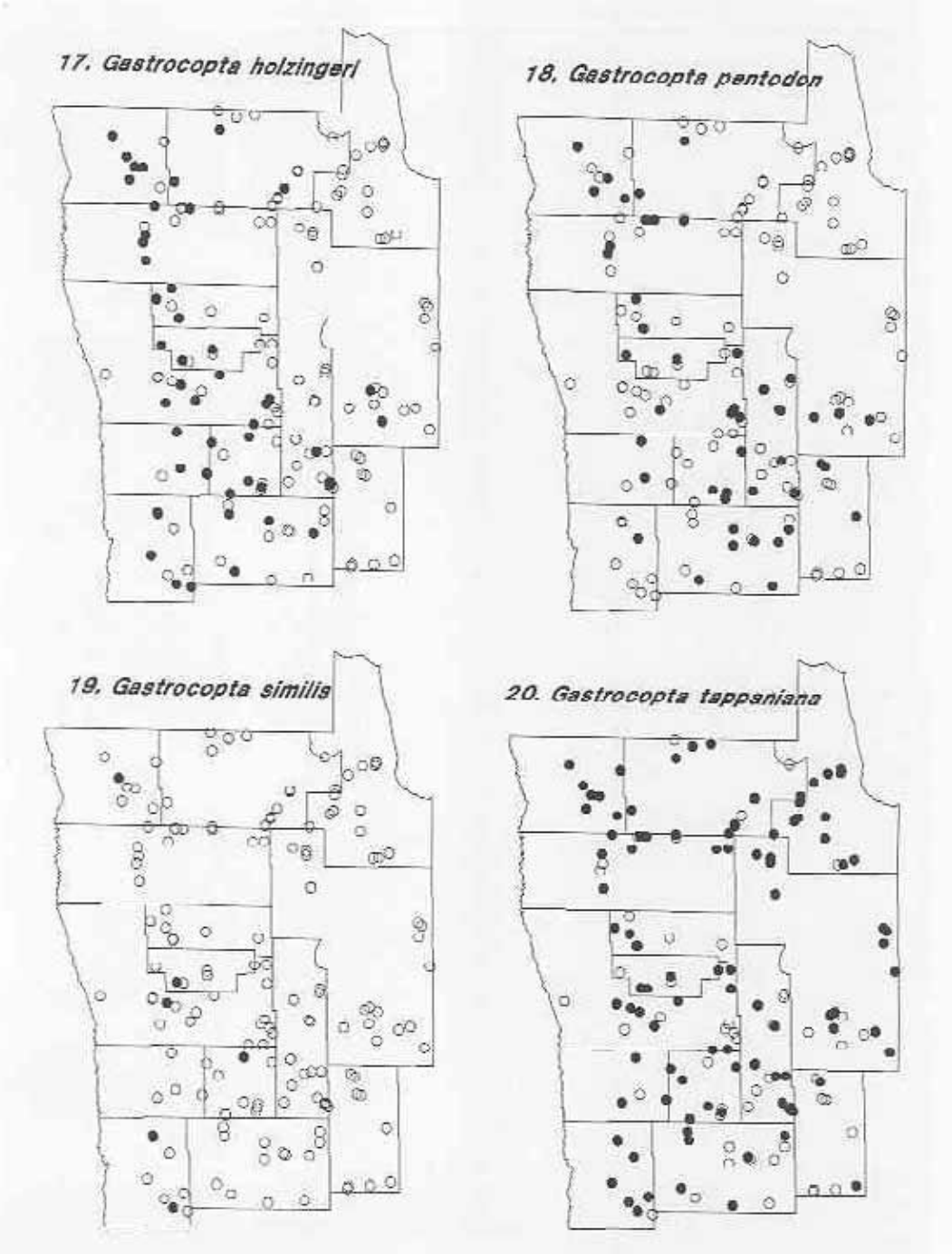
Distribution maps for the 54 encountered species. Dark circles represent sites of occurrence, while open circles represents sites of absence.

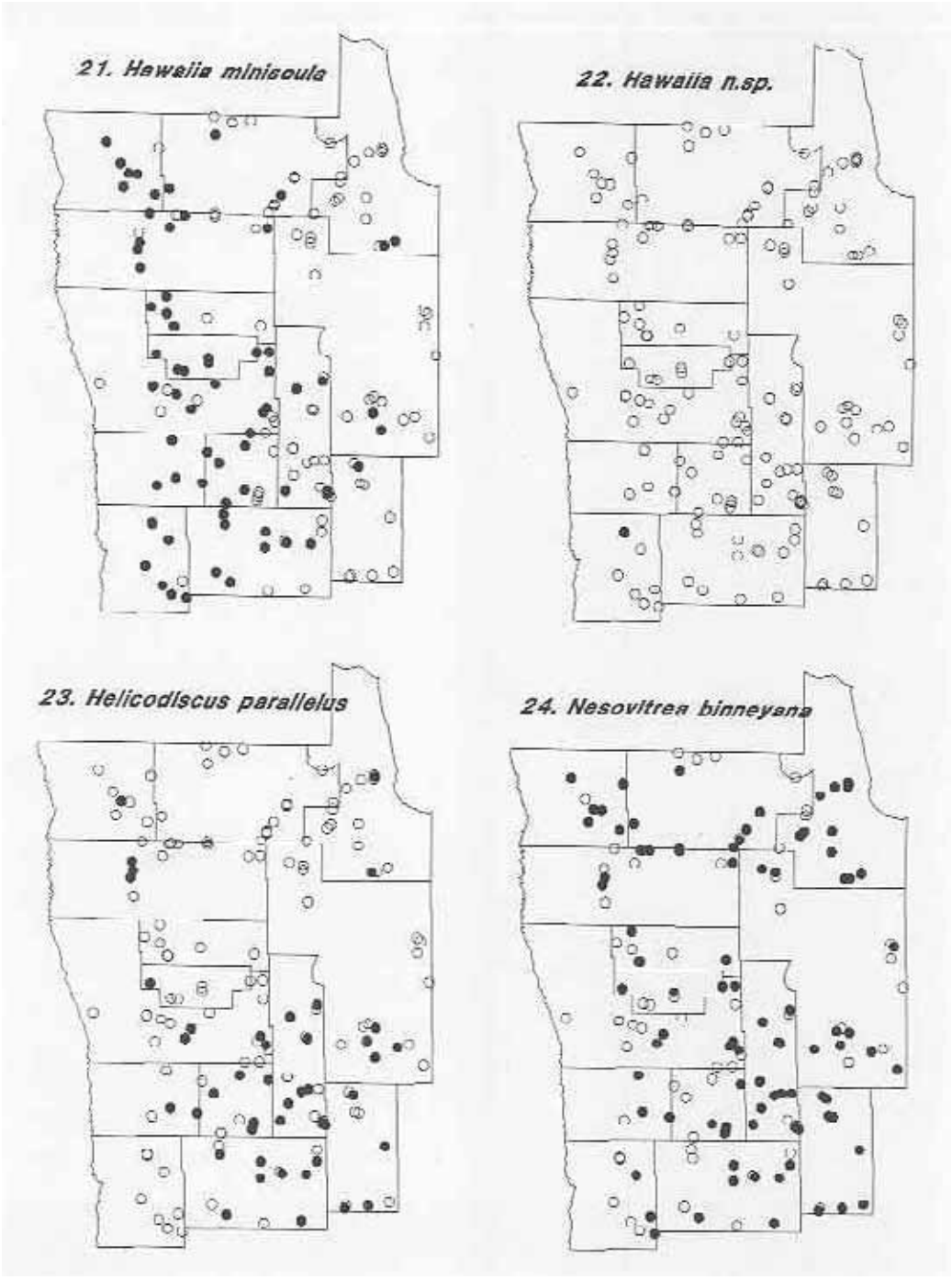

1. Anguispira alternata
2. Carychium exiguum
3. Carychium exile
4. Catinella avara

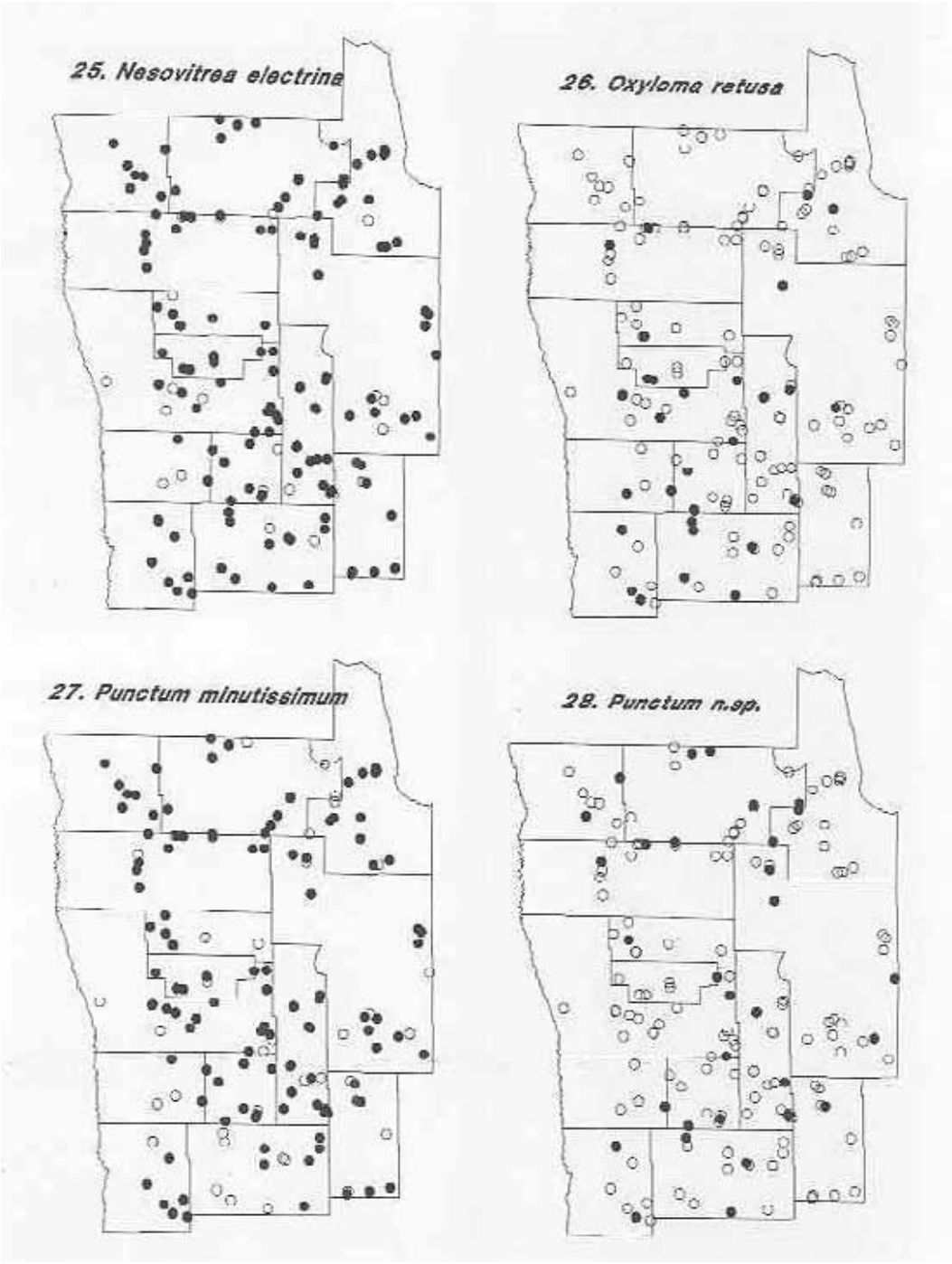

5. Catinella exile
6. Catinella cf. vermeta
7. Cochlicopa lubrica
8. Cochlicopa lubricella

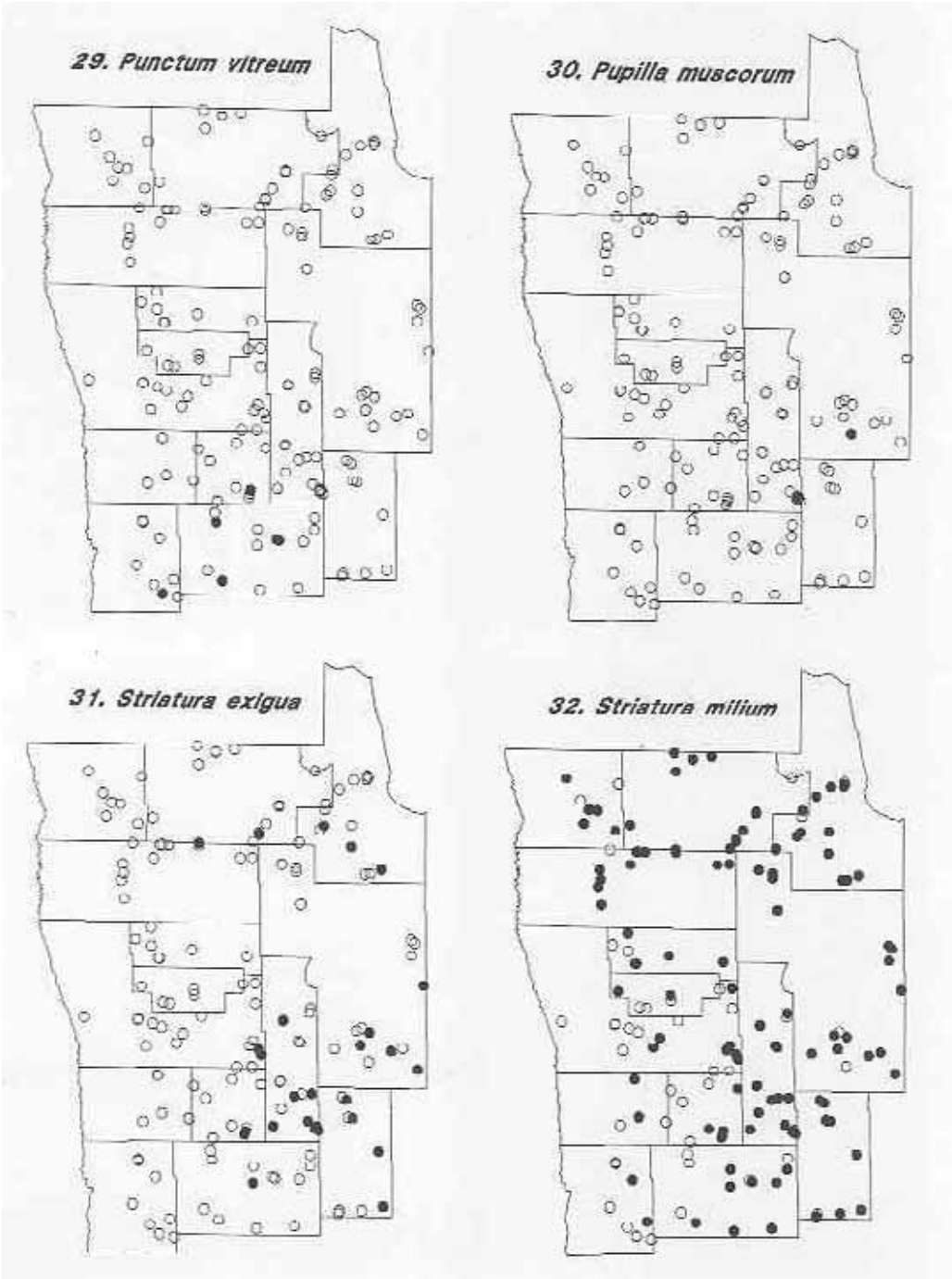

9. Columella simplex
10. Deroceras spp.
11. Discus catskillensis
12. Discus cronkhitei

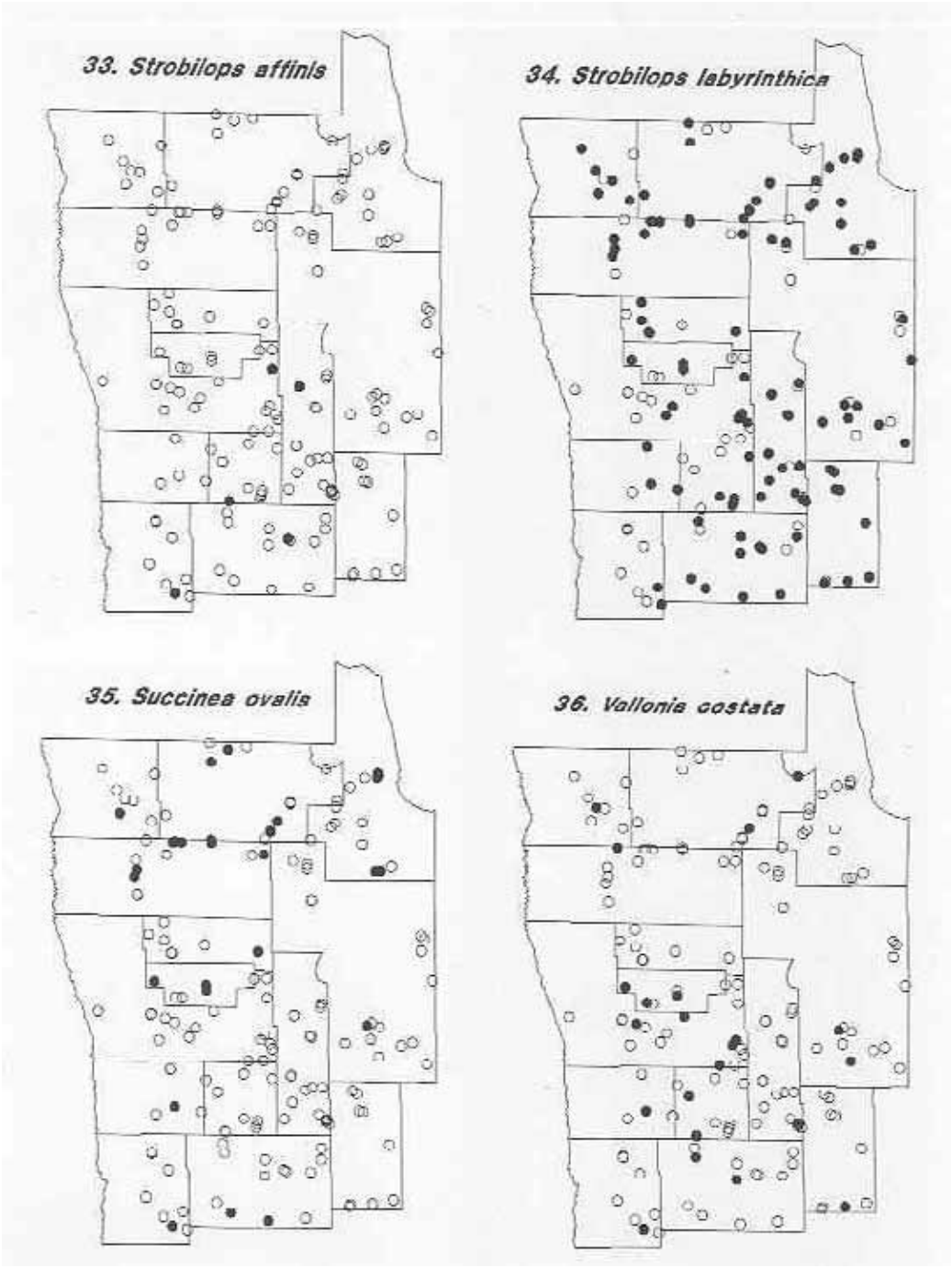

13. Euconulus alderi
14. Euconulus fulvus
15. Gastrocopta abbreviata
16. Gastrocopta contracta

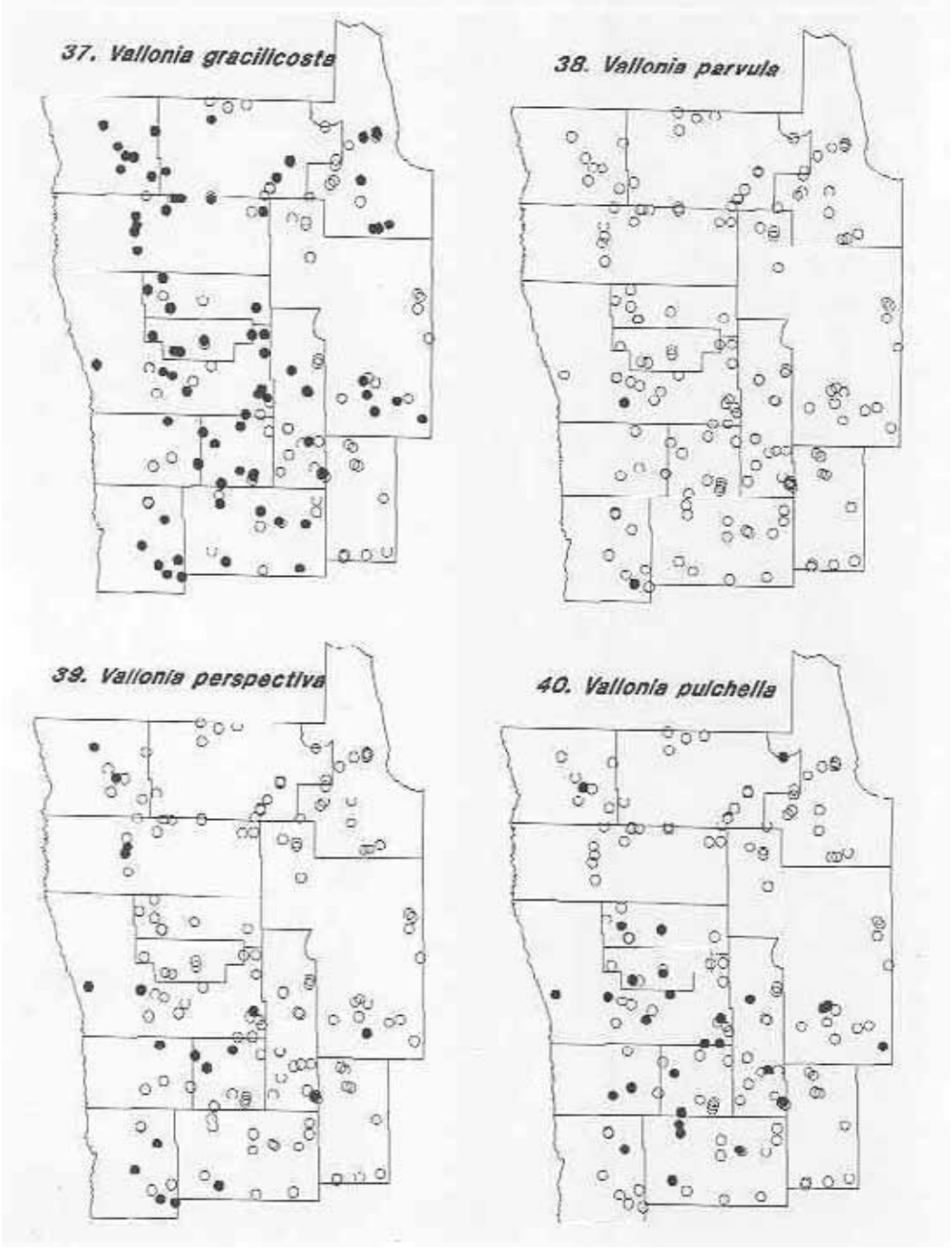

17. Gastrocopta holzingeri
18. Gastrocopta pentodon
19. Gastrocopta similis
20. Gastrocopta tappaniana

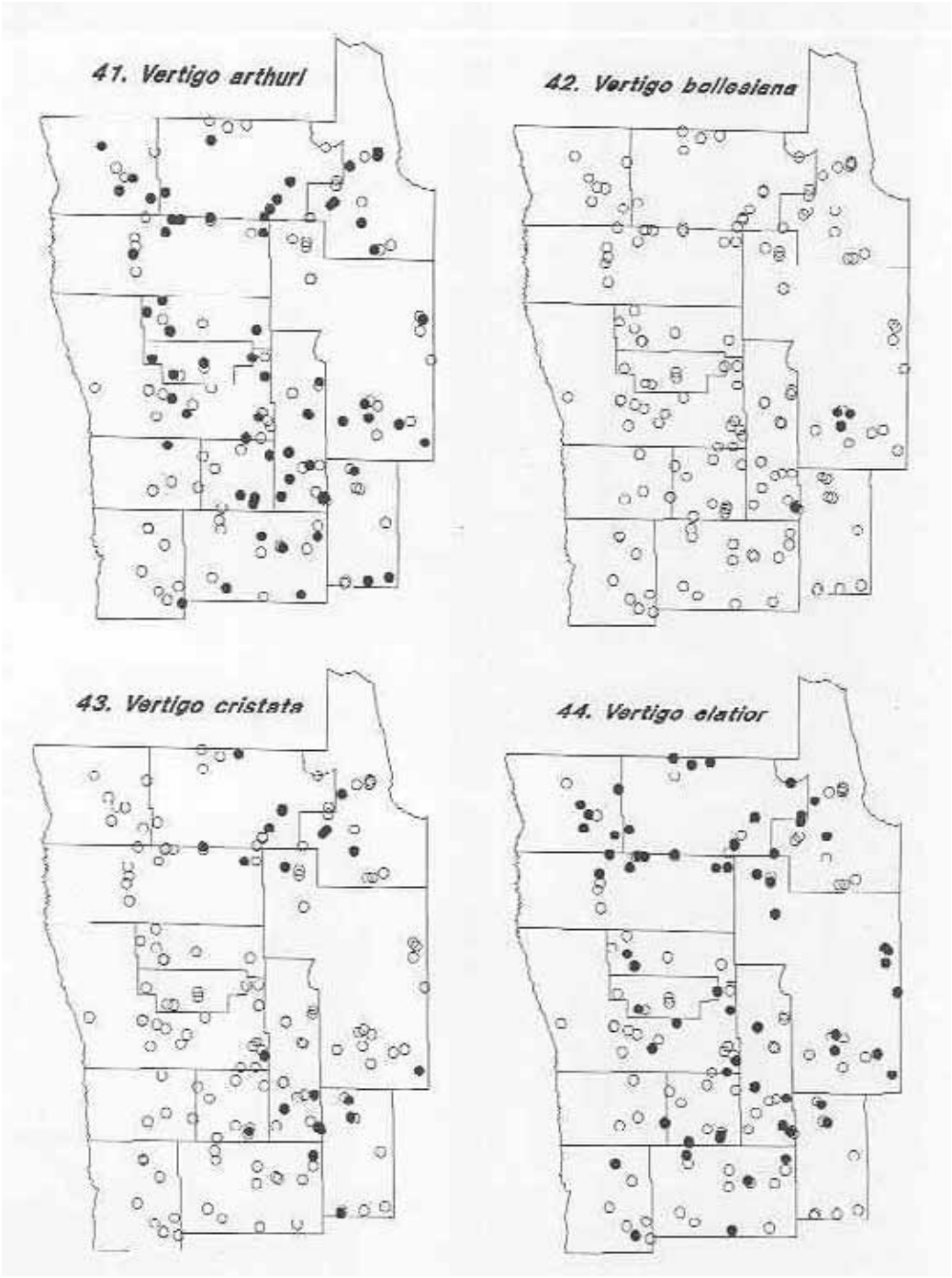

21. Hawaiia miniscula
22. Hawaiia n.sp.
23. Helicodiscus parallelus
24. Nesovitrea binneyana

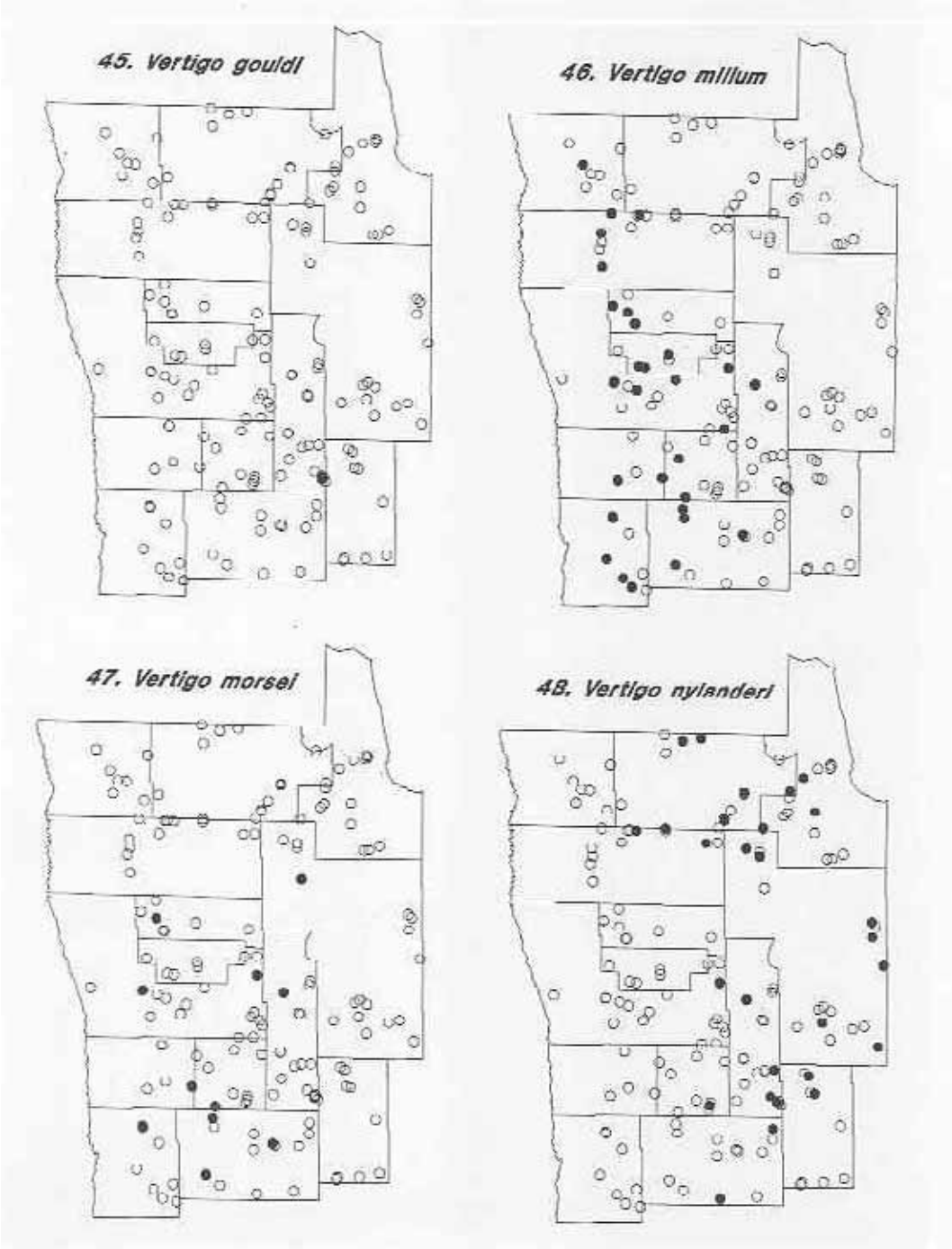

25. Nesovitrea electrina
26. Oxyloma retusa
27. Punctum minutissimum
28. Punctum n.sp.

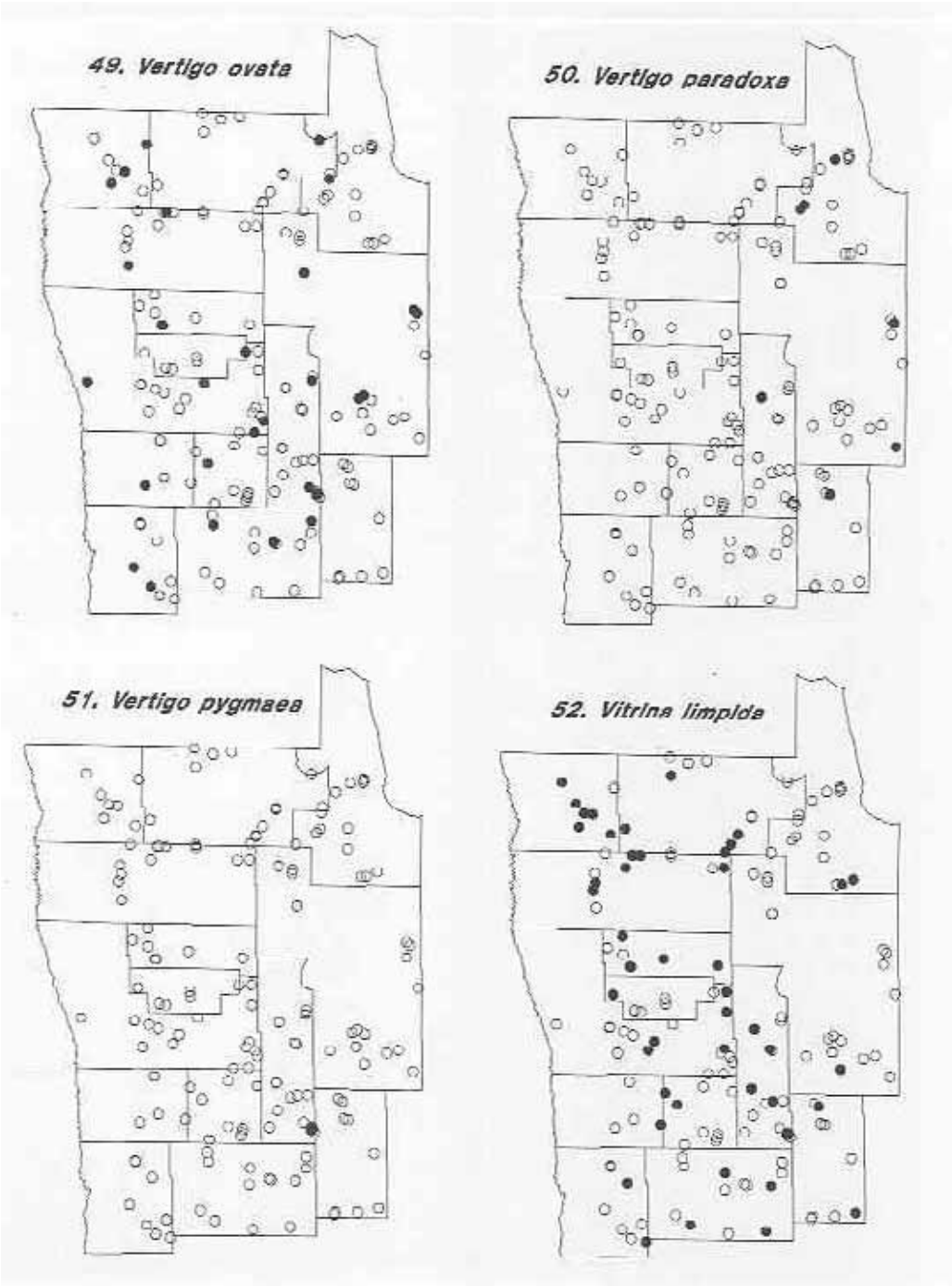

29. Punctum vitreum
30. Pupilla muscorum
31. Striatura exigua
32. Striatura milium

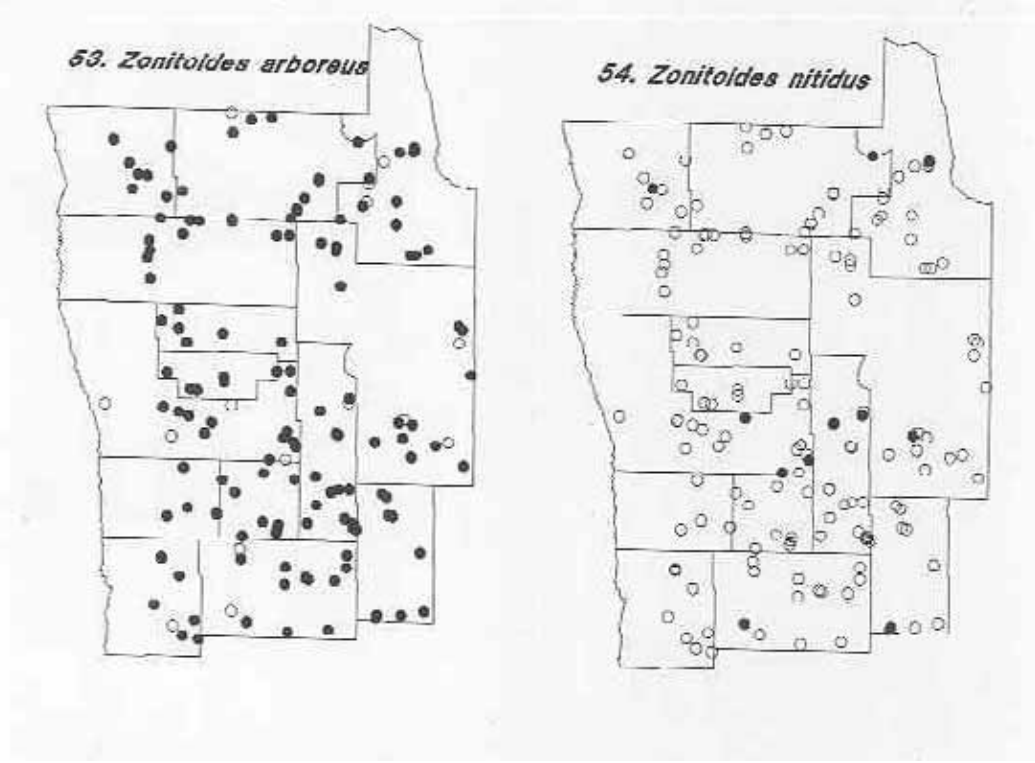

33. Strobilops affinis
34. Strobilops labyrinthica
35. Succinea ovalis
36. Vallonia costata


37. Vallonia gracilicosta
38. Vallonia parvula
39. Vallonia perspectiva
40. Vallonia pulchella


41. Vertigo arthuri
42. Vertigo bollesiana
43. Vertigo cristata
44. Vertigo elatior


45. Vertigo gouldi
46. Vertigo milium
47. Vertigo morsei
48. Vertigo nylanderi


49. Vertigo ovata
50. Vertigo paradoxa
51. Vertigo pygmaea
52. Vitrina limpida


53. Zonitoides arboreus
54. Zonitoides nitidus

APPENDIX II:

Alphabetical enumeration of sample sites by county, with location, habitat type, richness, total abundance, and species list.

Becker County

Audubon South

Location: 95.9798 W., 46.8329 N.
Habitat Type: Fen
Richness: 14

Habitat Group: Lowland Grassland
Total Abundance: 1816

Small, wet fen emerging from a small gravel knoll. Plant species richness was not as high as other fens in the region, with the only rare species noted being *Rhynchospora capillacea*.

Oxyloma retusa	(535)	*Catinella exile*	(12)
Carychium exiguum	(341)	*Vallonia pulchella*	(8)
Gastrocopta tappaniana	(179)	*Vertigo morsei*	(5)
Euconulus alderi	(173)	*Deroceras laeve*	(2)
Vertigo milium	(144)	*Nesovitrea electrina*	(2)
Hawaiia minuscula	(39)	*Strobilops labyrinthica*	(1)
Zonitoides nitidus	(16)	Immature Pupillidae	(346)
Discus cronkhitei	(13)		

Callaway North

Location: 95.9229 W., 47.0657 N.
Habitat Type: Mesic Prairie
Richness: 17

Habitat Group: Upland Grassland
Total Abundance: 362

Small, degraded mesic railroad prairie remnant. Very little native vegetation remained, with this being limited to a small strip on the birm above the tracks.

Nesovitrea electrina	(45)	*Oxyloma retusa*	(5)
Catinella avara	(41)	*Vertigo ovata*	(3)
Hawaiia minuscula	(41)	*Zonitoides arboreus*	(3)
Discus cronkhitei	(39)	*Euconulus alderi*	(2)
Vallonia pulchella	(29)	*Gastrocopta holzingeri*	(2)
Vallonia gracilicosta	(26)	*Vertigo milium*	(2)
Punctum vitreum	(12)	*Helicodiscus parallelus*	(1)
Carychium exiguum	(11)	Immature *Vallonia*	(79)
Vallonia costata	(9)	Immature Pupillidae	(6)
Gastrocopta tappaniana	(6)		

Dunton Locks Park

Location: 95.8775 W., 46.7858 N.
Habitat Type: Oak Forest
Richness: 21

Habitat Group: Upland Forest
Total Abundance: 949

Mature dry-mesic Bur Oak, Aspen, and Ash with Prickly Ash understory with deep litter on south-facing sand-gravel slope.

Strobilops labyrinthica	(97)	*Cochlicopa lubricella*	(16)
Striatura milium	(83)	*Euconulus fulvus*	(14)
Gastrocopta holzingeri	(82)	*Discus catskillensis*	(10)
Vallonia gracilicosta	(75)	*Nesovitrea binneyana*	(8)
Zonitoides arboreus	(70)	*Succinea ovalis*	(7)
Gastrocopta pentodon	(61)	*Helicodiscus parallelus*	(6)
Hawaiia minuscula	(57)	***Vertigo arthuri***	**(4)**
Nesovitrea electrina	(53)	*Columella simplex*	(3)
Punctum vitreum	(52)	*Carychium exile*	(1)
Vitrina limpida	(41)	Immature *Vallonia*	(125)
Vallonia perspectiva	(36)	Immature Pupillidae	(31)
Gastrocopta contracta	(17)		

Frazee East

Location: 95.6122 W., 46.7469 N.
Habitat Type: Tamarack Wetland
Richness: 17

Habitat Group: Lowland Forest
Total Abundance: 654

Rather dry, open Tamarack-Paper Birch wetland with *Cinna arundinaceae* dominated ground layer.

Strobilops labyrinthica	(176)	*Cochlicopa lubricella*	(8)
Carychium exiguum	(128)	*Euconulus alderi*	(7)
Nesovitrea electrina	(87)	*Catinella avara*	(5)
Discus cronkhitei	(43)	***Vertigo nylanderi***	**(3)**
Gastrocopta tappaniana	(30)	*Punctum* n.sp.	(2)
Striatura milium	(23)	*Anguispira alternata*	(1)
Vertigo elatior	(21)	*Deroceras laeve*	(1)
Succinea ovalis	(13)	*Oxyloma retusa*	(1)
Zonitoides arboreus	(13)	Immature Pupillidae	(92)

Goldenrod

Location: 95.2333 W., 47.0925 N.
Habitat Type: Tamarack Wetland
Richness: 12

Habitat Group: Lowland Forest
Total Abundance: 142

Acidic Tamarack, Alder, Bog Birch wetland forest with frequent *Sphagnum* moss cover. Collection was limited to non-*Sphagnum* areas, especially those with thick leaf litter.

Zonitoides arboreus	(27)	*Vertigo elatior*	(5)
Nesovitrea electrina	(22)	*Vertigo ovata*	(5)
Carychium exile	(17)	*Cochlicopa lubricella*	(2)
Gastrocopta tappaniana	(15)	***Vertigo nylanderi***	(1)
Vertigo cristata	(12)	Immature Pupillidae	(22)
Euconulus alderi	(7)	Immature Succineidae	(1)
Punctum minutissimum	(6)		

Greenwater Lake 1

Location: 95.4997 W., 46.9888 N.
Habitat Type: Fen
Richness: 19

Habitat Group: Lowland Grassland
Total Abundance: 2132

Rich, calcareous sedge-dominated fen mat at northwestern margin of Greenwater Lake. Sage Willow also present.

Vertigo elatior	(388)	*Vertigo ovata*	(20)
Carychium exile	(238)	*Vertigo milium*	(8)
Gastrocopta tappaniana	(168)	*Vallonia pulchella*	(5)
Euconulus alderi	(113)	*Punctum vitreum*	(4)
Carychium exiguum	(87)	*Punctum* n.sp.	(3)
Nesovitrea electrina	(81)	***Vertigo morsei***	(2)
Strobilops labyrinthica	(44)	*Discus cronkhitei*	(1)
Oxyloma retusa	(41)	*Vallonia gracilicosta*	(1)
Gastrocopta contracta	(27)	*Zonitoides arboreus*	(1)
Strobilops affinis	(26)	Immature Pupillidae	(874)

Greenwater Lake 2

Location: 95.4830 W., 46.9812 N.
Habitat Type: Oak Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 669

Mature, mesic Bur Oak, Aspen, Elm forest with deep leaf litter.

Striatura milium	(132)	*Helicodiscus parallelus*	(7)
Nesovitrea binneyana	(107)	*Nesovitrea electrina*	(5)
Strobilops labyrinthica	(103)	***Vertigo arthuri***	**(5)**
Zonitoides arboreus	(86)	*Columella simplex*	(4)
Discus catskillensis	(60)	*Hawaiia minuscula*	(3)
Euconulus fulvus	(49)	*Anguispira alternata*	(1)
Carychium exile	(41)	*Catinella avara*	(1)
Punctum vitreum	(22)	Immature Pupillidae	(9)
Gastrocopta pentodon	(20)	Immature *Cochlicopa*	(2)
Gastrocopta contracta	(12)		

Ogema West

Location: 95.9331 W., 47.1089 N.
Habitat Type: Fen
Richness: 15

Habitat Group: Lowland Grassland
Total Abundance: 5001

Rich, mounded calcareous fen with low *Rhynchospora*-sedge mat and frequent flarks.

Carychium exiguum	(1179)	*Discus cronkhitei*	(82)
Catinella exile	(935)	*Euconulus alderi*	(59)
Gastrocopta tappaniana	(523)	*Oxyloma retusa*	(47)
Hawaiia minuscula	(311)	*Deroceras laeve*	(35)
Nesovitrea electrina	(306)	***Vertigo morsei***	**(15)**
Punctum n.sp.	(241)	*Vertigo elatior*	(5)
Vertigo milium	(199)	*Strobilops labyrinthica*	(1)
Vallonia pulchella	(87)	Immature Pupillidae	(976)

Spruce Grove Town Hall

Location: 95.3475 W., 46.7603 N.
Habitat Type: Aspen Forest
Richness: 17

Habitat Group: Upland Forest
Total Abundance: 423

Mature Aspen forest with Sugar Maple, Ash, and Ironwood with rather thin litter over clay-loam soil.

Strobilops labyrinthica	(110)	*Columella simplex*	(13)
Nesovitrea binneyana	(55)	*Gastrocopta pentodon*	(12)
Vallonia gracilicosta	(48)	*Discus catskillensis*	(9)
Striatura milium	(36)	*Helicodiscus parallelus*	(9)
Nesovitrea electrina	(34)	*Carychium exile*	(8)
Euconulus fulvus	(24)	*Zonitoides arboreus*	(6)

Vitrina limpida	(18)	*Catinella avara*	(1)
Punctum minutissimum	(15)	Immature Pupillidae	(10)
Vertigo arthuri	(14)	Immature Succineidae	(1)

Straight Lake

Location: 95.3112 W., 46.9779 N.
Habitat Type: Sand Prairie
Richness: 13

Habitat Group: Upland Grassland
Total Abundance: 281

Dry sand prairie with deep leaf litter under *Prunus-Corylus* scrub.

Punctum minutissimum	(52)	*Vitrina limpida*	(13)
Striatura milium	(35)	*Helicodiscus parallelus*	(12)
Nesovitrea binneyana	(33)	*Vallonia gracilicosta*	(12)
Gastrocopta holzingeri	(28)	*Euconulus fulvus*	(11)
Hawaiia minuscula	(26)	*Gastrocopta pentodon*	(1)
Cochlicopa lubricella	(22)	Immature Pupillidae	(16)
Zonitoides arboreus	(20)		

Tamarac NWR

Location: 95.6358 W., 46.9586 N.
Habitat Type: Maple-Basswood Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 365

Mature upland Sugar Maple-Basswood-Red Oak forest over heavy clay soil.

Carychium exile	(58)	*Columella simplex*	(15)
Zonitoides arboreus	(47)	*Striatura exigua*	(9)
Striatura milium	(46)	*Helicodiscus parallelus*	(7)
Discus catskillensis	(42)	*Nesovitrea electrina*	(7)
Nesovitrea binneyana	(35)	*Gastrocopta pentodon*	(6)
Strobilops labyrinthica	(25)	*Cochlicopa lubricella*	(4)
Vallonia costata	(23)	*Gastrocopta contracta*	(4)
Punctum minutissimum	(17)	*Discus cronkhitei*	(2)
Euconulus fulvus	(16)	*Hawaiia minuscula*	(2)

Two Inlets

Location: 95.2358 W., 47.0384 N.
Habitat Type: Aspen Forest
Richness: 15

Habitat Group: Upland Forest
Total Abundance: 819

Mature, diverse forest of Aspen, Red Pine, Paper Birch, and Red Maple with moderately thick leaf litter.

Discus catskillensis	(191)	*Punctum minutissimum*	(20)
Striatura milium	(157)	*Carychium exile*	(17)
Strobilops labyrinthica	(117)	*Helicodiscus parallelus*	(16)
Nesovitrea binneyana	(93)	*Euconulus fulvus*	(10)
Zonitoides arboreus	(69)	*Columella simplex*	(7)
Cochlicopa lubricella	(43)	*Carychium exiguum*	(1)
Gastrocopta pentodon	(39)	*Vertigo arthuri*	(1)
Nesovitrea electrina	(25)	Immature Pupillidae	(13)

Two Island Lake

Location: 95.6337 W., 47.0353 N.
Habitat Type: Aspen Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 2456

Mixed up forest of Aspen, Basswood, Ash, and Paper Birch with thick leaf litter well-drained soil.

Vallonia gracilicosta	(581)	*Euconulus fulvus*	(51)
Strobilops labyrinthica	(403)	*Vertigo arthuri*	(39)
Punctum minutissimum	(340)	*Columella simplex*	(19)
Gastrocopta holzingeri	(185)	*Gastrocopta contracta*	(16)
Cochlicopa lubricella	(153)	*Hawaiia minuscula*	(10)
Nesovitrea binneyana	(137)	*Discus catskillensis*	(9)
Striatura milium	(130)	*Vitrina limpida*	(3)
Gastrocopta pentodon	(108)	*Helicodiscus parallelus*	(2)
Carychium exile	(93)	Immature Pupillidae	(122)
Zonitoides arboreus	(55)		

Beltrami County

Battle River

Location: 94.5240 W., 48.0325 N.
Habitat Type: Tamarack Wetland
Richness: 9

Habitat Group: Lowland Forest
Total Abundance: 254

Wet, acidic Tamarack-White Cedar wetland with abundant *Sphagnum*.

Carychium exiguum	(162)	*Vertigo elatior*	(10)
Gastrocopta tappaniana	(27)	*Striatura milium*	(2)

Nesovitrea electrina	(19)	*Vertigo nylanderi*	(2)
Punctum minutissimum	(13)	Immature Pupillidae	(7)
Euconulus alderi	(10)	Immature Succineidae	(2)

Fourtown 1

Location: 95.3058 W., 48.2655 N.
Habitat Type: Fen
Richness: 13
Habitat Group: Lowland Grassland
Total Abundance: 1403

Moss and leaf litter under small shrubs on slight rises of large calcareous fen sedge mat.

Carychium exiguum	(625)	*Zonitoides arboreus*	(17)
Gastrocopta tappaniana	(124)	*Oxyloma retusa*	(13)
Vertigo morsei	(93)	*Deroceras laeve*	(6)
Euconulus alderi	(83)	*Catinella avara*	(5)
Vertigo elatior	(52)	*Vertigo ovata*	(2)
Nesovitrea electrina	(41)	*Striatura milium*	(1)
Punctum n.sp.	(27)	Immature Pupillidae	(314)

Fourtown 2

Location: 95.3089 W., 48.2649 N.
Habitat Type: Aspen Grove
Richness: 10
Habitat Group: Upland Forest
Total Abundance: 188

Wet-mesic aspen and balsam poplar grove on island in fen.

Punctum minutissimum	(65)	*Zonitoides arboreus*	(6)
Nesovitrea electrina	(58)	*Deroceras laeve*	(4)
Carychium exiguum	(27)	*Vertigo elatior*	(1)
Euconulus fulvus	(19)	*Vertigo ovata*	(1)
Gastrocopta tappaniana	(6)	Immature Succineidae	(1)

Lake Bemidji State Park

Location: 94.8247 W., 47.5328 N.
Habitat Type: Lakeshore
Richness: 13
Habitat Group: Upland Forest
Total Abundance: Field Sieve

Dry, disturbed, sandy shore above lake at boatramp

Catinella avara	*Pupilla muscorum*
Cochlicopa lubricella	*Vallonia costata*

Euconulus fulvus
Gastrocopta holzingeri
Hawaiia minuscula
Helicodiscus parallelus
Punctum minutissimum
Vallonia gracilicosta
Vallonia perspectiva
Vitrina limpida
Zonitoides arboreus

Moose River Road

Location: 95.4404 W., 48.4517 N.
Habitat Type: Tamarack Wetland
Richness: 19

Habitat Group: Lowland Forest
Total Abundance: 1097

Rich, mature Tamarack-Willow-Sedge swamp forest with deep leaf litter and moss

Carychium exiguum	(674)	*Deroceras laeve*	(8)
Nesovitrea electrina	(88)	*Cochlicopa lubrica*	(6)
Strobilops labyrinthica	(83)	*Euconulus fulvus*	(5)
Striatura milium	(37)	*Columella simplex*	(4)
Gastrocopta tappaniana	(36)	*Zonitoides arboreus*	(3)
Euconulus alderi	(33)	*Discus cronkhitei*	(2)
Punctum minutissimum	(28)	*Nesovitrea binneyana*	(1)
Discus catskillensis	(19)	*Vertigo cristata*	(1)
Vertigo nylanderi	**(19)**	Immature Pupillidae	(31)
Vertigo elatior	(16)	Immature Succineidae	(2)

Patrolman's Walking Trail

Location: 95.3424 N., 48.4160 W.
Habitat Type: Tamarack Wetland
Richness: 15

Habitat Group: Lowland Forest
Total Abundance: 354

Dry, tamarack-sedge swamp forest

Carychium exiguum	(155)	*Punctum* n.sp.	(4)
Nesovitrea electrina	(70)	*Columella simplex*	(2)
Striatura milium	(36)	*Zonitoides arboreus*	(2)
Gastrocopta tappaniana	(27)	*Carychium exile*	(1)
Euconulus alderi	(10)	*Deroceras laeve*	(1)
Vertigo elatior	(10)	Immature Pupillidae	(18)
Vertigo nylanderi	**(9)**	Immature Succineidae	(1)
Discus cronkhitei	(7)	Immature *Cochlicopa*	(1)

Patrolman's Walking Trail North

Location: 95.3415 N., 48.4367 W.
Habitat Type: Aspen Forest
Richness: 14

Habitat Group: Upland Forest
Total Abundance: 827

Mature Aspen-Balsam Poplar forest with moderately deep leaf litter

Strobilops labyrinthica	(175)	*Zonitoides arboreus*	(40)
Carychium exile	(150)	*Punctum minutissimum*	(39)
Striatura milium	(107)	*Cochlicopa lubricella*	(29)
Nesovitrea binneyana	(67)	*Columella simplex*	(7)
Discus catskillensis	(63)	*Discus cronkhitei*	(5)
Nesovitrea electrina	(47)	Immature Pupillidae	(13)
Euconulus fulvus	(42)	Immature Succineidae	(1)
Gastrocopta tappaniana	(42)		

Pennington Bog SNA

Location: 94.4790 47.4999
Habitat Type: Tamarack Wetland
Richness: 21

Habitat Group: Lowland Forest
Total Abundance: 532

Mature, rich Tamarack-White Cedar swamp forest with deep moss

Strobilops labyrinthica	(107)	***Vertigo arthuri***	(7)
Striatura milium	(101)	*Carychium exiguum*	(6)
Carychium exile	(82)	*Vertigo cristata*	(5)
Striatura exigua	(53)	***Vertigo nylanderi***	(4)
Discus catskillensis	(31)	*Columella simplex*	(3)
Nesovitrea binneyana	(31)	*Vertigo elatior*	(3)
Punctum minutissimum	(22)	***Vertigo paradoxa***	(3)
Nesovitrea electrina	(17)	*Discus cronkhitei*	(1)
Vallonia pulchella	(13)	*Gastrocopta tappaniana*	(1)
Zonitoides arboreus	(9)	*Vallonia gracilicosta*	(1)
Euconulus alderi	(7)	Immature Pupillidae	(25)

Puposky Lake

Location: 94.9106 W., 47.6793 N.
Habitat Type: Lakeshore
Richness: 25

Habitat Group: Upland Forest
Total Abundance: Field Sieve

Sandy, wooded, bank along lakeshore

Anguispira alternata
Carychium exiguum
Carychium exile
Catinella avara
Cochlicopa lubricella
Columella simplex
Euconulus alderi
Euconulus fulvus
Gastrocopta holzingeri
Gastrocopta tappaniana
Nesovitrea binneyana
Nesovitrea electrina
Oxyloma retusa
Punctum minutissimum
Striatura milium
Strobilops labyrinthica
Succinea ovalis
Vallonia costata
Vallonia gracilicosta
Vallonia pulchella
Vertigo arthuri
Vertigo bollesiana
Vertigo ovata
Zonitoides arboreus
Zonitoides nitidus

Puposky Roadside

Location: 94.8755 W., 47.6927 N.
Habitat Type: Calcareous Meadow
Richness: 5
Habitat Group: Lowland Grassland
Total Abundance: 483

Damp calcareous roadside ditch with exposed till

Vallonia pulchella	(271)	*Gastrocopta tappaniana*	(12)
Vertigo elatior	(101)	*Carychium exiguum*	(1)
Vertigo ovata	(53)	Immature Pupillidae	(45)

Roadside Lake

Location: 94.6648 W., 47.5841 N.
Habitat Type: Maple-Basswood Forest
Richness: 17
Habitat Group: Upland Forest
Total Abundance: 708

Mature Sugar Maple, Bigtooth Aspen, White Pine forest with moderately deep leaf litter.

Carychium exile	(142)	Helicodiscus parallelus	(24)
Strobilops labyrinthica	(124)	Gastrocopta pentodon	(23)
Discus catskillensis	(78)	Columella simplex	(9)
Zonitoides arboreus	(58)	Gastrocopta contracta	(9)
Striatura milium	(56)	Vallonia gracilicosta	(9)
Nesovitrea binneyana	(42)	Nesovitrea electrina	(7)
Punctum minutissimum	(41)	**Vertigo arthuri**	**(5)**
Striatura exigua	(31)	Cochlicopa lubricella	(4)
Euconulus fulvus	(26)	Immature Pupillidae	(20)

Shooks North

Location: 94.4412 W., 47.8939 N.
Habitat Type: Tamarack Wetland
Richness: 13

Habitat Group: Lowland Forest
Total Abundance: 239

Alder and Bog Birch dominated neutral margin of otherwise acidic Tamarack swamp forest

Striatura exigua	(45)	*Vertigo nylanderi*	(8)
Striatura milium	(45)	*Zonitoides arboreus*	(8)
Nesovitrea electrina	(33)	*Gastrocopta tappaniana*	(7)
Punctum n.sp.	(17)	*Discus catskillensis*	(6)
Strobilops labyrinthica	(17)	*Euconulus alderi*	(5)
Carychium exiguum	(15)	*Columella simplex*	(1)
Vertigo elatior	(13)	Immature Pupillidae	(19)

South Twin Lake

Location: 94.5826 W., 47.5985 N.
Habitat Type: Tamarack Wetland
Richness: 6

Habitat Group: Lowland Forest
Total Abundance: 84

Deep leaf litter under Alders at margin of acidic tamarack swamp forest

Nesovitrea electrina	(51)	*Gastrocopta tappaniana*	(4)
Punctum n.sp.	(16)	*Vertigo elatior*	(3)
Striatura milium	(8)	*Euconulus alderi*	(2)

Spring Lake

Location: 95.0662 W., 47.5927 N.
Habitat Type: Aspen Forest
Richness: 12

Habitat Group: Upland Forest
Total Abundance: 159

Early successional dry Aspen-Oak-Jack Pine forest with relatively thin leaf litter

Nesovitrea binneyana	(44)	*Columella simplex*	(10)
Strobilops labyrinthica	(36)	*Euconulus fulvus*	(10)
Discus catskillensis	(14)	*Zonitoides arboreus*	(5)
Gastrocopta pentodon	(13)	*Nesovitrea electrina*	(2)
Vertigo arthuri	(12)	*Discus cronkhitei*	(1)
Striatura milium	(11)	Immature *Cochlicopa*	(1)

Turtle Lake 1

Location: 94.8835 W., 47.6134 N.
Habitat Type: Black Ash Wetland
Richness: 23

Habitat Group: Lowland Forest
Total Abundance: 447

Wet Black Ash-Balsam Fir forest along lake margin

Carychium exile	(70)	*Gastrocopta contracta*	(9)
Helicodiscus parallelus	(59)	*Columella simplex*	(8)
Cochlicopa lubricella	(56)	*Vallonia gracilicosta*	(7)
Nesovitrea electrina	(38)	*Hawaiia minuscula*	(5)
Strobilops labyrinthica	(37)	*Nesovitrea binneyana*	(5)
Striatura exigua	(27)	*Vertigo elatior*	(4)
Zonitoides arboreus	(27)	*Gastrocopta tappaniana*	(3)
Discus catskillensis	(24)	*Deroceras laeve*	(1)
Punctum minutissimum	(16)	*Gastrocopta pentodon*	(1)
Striatura milium	(16)	***Vertigo nylanderi***	(1)
Carychium exiguum	(12)	Immature Succineidae	(5)
Euconulus fulvus	(12)	Immature Pupillidae	(4)

Turtle Lake 2

Location: 94.8835 W., 47.6125 N.
Habitat Type: White Cedar Wetland
Richness: 22

Habitat Group: Lowland Forest
Total Abundance: 782

Mature, lowland White Cedar-Black Ash forest with dense sedge-moss ground layer.

Carychium exiguum	(162)	*Euconulus alderi*	(13)
Carychium exile	(138)	*Nesovitrea binneyana*	(12)
Strobilops labyrinthica	(107)	*Zonitoides arboreus*	(8)
Striatura exigua	(81)	*Columella simplex*	(5)
Punctum minutissimum	(63)	*Nesovitrea electrina*	(5)
Helicodiscus parallelus	(28)	***Vertigo arthuri***	(4)
Striatura milium	(27)	***Vertigo nylanderi***	(4)
Discus catskillensis	(26)	*Discus cronkhitei*	(2)
Vertigo elatior	(23)	*Vallonia gracilicosta*	(2)
Gastrocopta tappaniana	(19)	***Vertigo bollesiana***	(1)
Euconulus fulvus	(14)	*Immature Pupillidae*	(25)
Cochlicopa lubricella	(13)		

Upper Lindgren Lake

Location: 94.8216 W., 47.6726 N.
Habitat Type: Oak Forest
Richness: 12

Habitat Group: Upland Forest
Total Abundance: 96

Mature, upland Oak-Aspen-Basswood-Sugar Maple forest with thin leaf litter over hard clay soil.

Carychium exile	(25)	*Euconulus fulvus*	(3)
Zonitoides arboreus	(21)	***Vertigo bollesiana***	(3)
Strobilops labyrinthica	(14)	*Columella simplex*	(2)
Discus catskillensis	(8)	*Helicodiscus parallelus*	(2)
Striatura exigua	(8)	*Punctum minutissimum*	(2)
Striatura milium	(7)	*Nesovitrea binneyana*	(1)

Waskish South 1

Location: 94.5040 N., 48.0902 W.
Habitat Type: White Cedar Wetland
Richness: 17

Habitat Group: Lowland Forest
Total Abundance: 486

Mature White Cedar-Tamarack swamp forest with dense sedge-moss ground cover.

Carychium exiguum	(187)	*Cochlicopa lubricella*	(14)
Striatura milium	(55)	*Euconulus fulvus*	(11)
Nesovitrea electrina	(52)	***Vertigo arthuri***	(6)
Nesovitrea binneyana	(31)	*Vertigo elatior*	(5)
Punctum minutissimum	(27)	***Vertigo paradoxa***	(2)
Discus cronkhitei	(20)	*Columella simplex*	(1)
Gastrocopta tappaniana	(18)	*Discus catskillensis*	(1)
Zonitoides arboreus	(16)	*Vertigo ovata*	(1)
Strobilops labyrinthica	(15)	Immature Pupillidae	(24)

Waskish South 2

Location: 94.5269 W., 48.1054 N.
Habitat Type: Tamarack Wetland
Richness: 14

Habitat Group: Lowland Forest
Total Abundance: 348

Tamarack-Alder swamp forest with dense sedge groundcover

Carychium exiguum	(112)	*Discus cronkhitei*	(5)
Gastrocopta tappaniana	(63)	*Euconulus alderi*	(4)

Nesovitrea electrina	(54)	*Catinella avara*	(3)
Punctum minutissimum	(41)	*Columella simplex*	(3)
Striatura milium	(18)	*Cochlicopa lubricella*	(2)
Vertigo elatior	(7)	*Vertigo ovata*	(2)
Vertigo nylanderi	(6)	Immature Pupillidae	(22)
Zonitoides arboreus	(6)		

Clay County

Barnesville WMA 1

Location: 96.2928 W., 46.7181 N.
Habitat Type: Xeric Prairie
Richness: 10

Habitat Group: Upland Grassland
Total Abundance: 469

Xeric gravel prairie with young aspen scrub

Gastrocopta holzingeri	(162)	*Gastrocopta similis*	(10)
Punctum minutissimum	(59)	*Vallonia gracilicosta*	(8)
Nesovitrea electrina	(52)	*Zonitoides arboreus*	(4)
Vallonia parvula	(44)	*Vallonia costata*	(1)
Euconulus fulvus	(32)	Immature *Vallonia*	(84)
Gastrocopta contracta	(13)		

Barnesville WMA 2

Location: 96.2938 W., 46.7193 N.
Habitat Type: Fen
Richness: 12

Habitat Group: Lowland Grassland
Total Abundance: 436

Cold, wet soil of *Phragmites*-dominated fen

Carychium exiguum	(178)	*Discus cronkhitei*	(5)
Gastrocopta tappaniana	(80)	*Hawaiia minuscula*	(2)
Nesovitrea electrina	(78)	*Strobilops affinis*	(1)
Euconulus alderi	(63)	*Succinea ovalis*	(1)
Punctum n.sp.	(11)	*Vertigo elatior*	(1)
Oxyloma retusa	(8)	*Zonitoides arboreus*	(1)
Gastrocopta contracta	(7)		

Barnesville WMA 3

Location: 96.2943 W., 46.7177 N.
Habitat Type: Shrub Carr
Richness: 19

Habitat Group: Lowland Forest
Total Abundance: 2073

Damp leaf litter of Dogwood-Willow-Bog Birch shrub swamp with dense sedge ground layer

Carychium exiguum	(665)	*Vertigo elatior*	(20)
Nesovitrea electrina	(285)	*Punctum vitreum*	(19)
Punctum n.sp.	(255)	*Vallonia gracilicosta*	(16)
Gastrocopta tappaniana	(202)	*Discus catskillensis*	(8)
Euconulus alderi	(198)	*Deroceras laeve*	(5)
Discus cronkhitei	(142)	*Oxyloma retusa*	(5)
Strobilops affinis	(30)	*Vallonia perspectiva*	(2)
Zonitoides arboreus	(24)	*Hawaiia minuscula*	(1)
Gastrocopta contracta	(23)	*Vertigo milium*	(1)
Succinea ovalis	(22)	Immature Pupillidae	(150)

Bjornson WMA

Location: 96.3567 W., 46.7623 N.
Habitat Type: Wet Prairie
Richness: 13

Habitat Group: Lowland Grassland
Total Abundance: 436

Wet-mesic prairie with copses of willow.

Hawaiia minuscula	(77)	*Punctum minutissimum*	(20)
Vertigo milium	(70)	*Catinella avara*	(16)
Carychium exiguum	(68)	*Vertigo ovata*	(4)
Gastrocopta tappaniana	(53)	*Deroceras laeve*	(2)
Nesovitrea electrina	(34)	*Oxyloma retusa*	(2)
Euconulus alderi	(32)	*Vallonia gracilicosta*	(1)
Discus cronkhitei	(23)	Immature Pupillidae	(34)

Bluestem Prairie

Location: 96.4792 W., 46.8550 N.
Habitat Type: Mesic Prairie
Richness: 13

Habitat Group: Upland Grassland
Total Abundance: 371

Heavily burned xeric gravel prairie with seepage areas in roadside ditch.

Gastrocopta tappaniana	(61)	*Zonitoides arboreus*	(12)
Hawaiia minuscula	(56)	*Vertigo ovata*	(5)

Gastrocopta holzingeri	(55)	*Euconulus alderi*	(3)
Punctum minutissimum	(38)	*Deroceras laeve*	(2)
Vertigo milium	(37)	*Nesovitrea electrina*	(2)
Catinella avara	(20)	*Vallonia gracilicosta*	(2)
Vallonia perspectiva	(16)	Immature Pupillidae	(61)

Felton Prairie 1

Location: 96.4391 W., 47.0643 N.
Habitat Type: Fen
Richness: 14

Habitat Group: Lowland Grassland
Total Abundance: 2370

Sedge turf and Bog Birch-Willow clumps of small fen.

Carychium exiguum	(549)	*Vertigo elatior*	(50)
Gastrocopta tappaniana	(267)	*Euconulus alderi*	(35)
Nesovitrea electrina	(237)	*Zonitoides arboreus*	(28)
Vertigo milium	(220)	*Catinella exile*	(26)
Punctum n.sp.	(184)	*Gastrocopta contracta*	(26)
Discus cronkhitei	(68)	*Vertigo morsei*	(2)
Hawaiia minuscula	(57)	Immature Pupillidae	(570)
Oxyloma retusa	(51)		

Felton Prairie 2

Location: 96.4388 W., 47.0668 N.
Habitat Type: Fen
Richness: 13

Habitat Group: Lowland Grassland
Total Abundance: 3132

Rich, wet sedge mat with common flarks in large fen.

Catinella exile	(803)	*Hawaiia* n.sp.	(31)
Gastrocopta tappaniana	(540)	*Vertigo morsei*	(19)
Carychium exiguum	(227)	*Oxyloma retusa*	(7)
Nesovitrea electrina	(144)	*Discus cronkhitei*	(4)
Punctum n.sp.	(139)	*Discus catskillensis*	(1)
Euconulus alderi	(120)	*Zonitoides arboreus*	(1)
Vertigo elatior	(107)	Immature Pupillidae	(943)
Vertigo milium	(46)		

Felton Prairie 3

Location: 96.4365 W., 47.0594 N.
Habitat Type: Xeric Prairie
Richness: 5

Habitat Group: Upland Grassland
Total Abundance: 63

Xeric gravel prairie with *Stipa* and leaf litter accumulations under *Symphiocarpus* bushes.

Gastrocopta holzingeri	(53)	*Catinella* cf. *'vermeta'*	(2)
Hawaiia minuscula	(4)	*Nesovitrea electrina*	(1)
Gastrocopta similis	(3)		

Lake Eleven

Location: 96.2171 W., 46.7885 N.
Habitat Type: Oak Forest
Richness: 17

Habitat Group: Upland Forest
Total Abundance: 247

Mature Bur Oak, Aspen, Basswood, White oak forest with thin leaf litter over hard clay soil.

Strobilops labyrinthica	(60)	*Nesovitrea electrina*	(8)
Nesovitrea binneyana	(57)	*Cochlicopa lubrica*	(7)
Euconulus fulvus	(20)	*Gastrocopta tappaniana*	(7)
Punctum minutissimum	(19)	*Columella simplex*	(4)
Zonitoides arboreus	(15)	*Deroceras laeve*	(3)
Discus catskillensis	(12)	*Cochlicopa lubricella*	(2)
Carychium exile	(11)	*Vallonia gracilicosta*	(1)
Striatura milium	(11)	Immature Succineidae	(1)
Gastrocopta contracta	(9)		

Tansen 1

Location: 96.1881 W., 46.7040 N.
Habitat Type: Xeric Prairie
Richness: 10

Habitat Group: Upland Grassland
Total Abundance: 146

Leaf litter accumulations under Leadplant and Snowberry shrubs on xeric, west-facing prairie ridge.

Nesovitrea binneyana	(46)	*Hawaiia minuscula*	(3)
Strobilops labyrinthica	(39)	*Vallonia gracilicosta*	(3)
Vallonia perspectiva	(25)	*Vitrina limpida*	(3)
Gastrocopta holzingeri	(20)	*Euconulus fulvus*	(2)
Punctum minutissimum	(4)	*Zonitoides arboreus*	(1)

Tansen 2

Location: 96.1877 W., 46.7051 N.
Habitat Type: Aspen Forest
Richness: 12

Habitat Group: Upland Forest
Total Abundance: 808

Deep leaf litter of Aspen-Chokecherry grove on northwest-facing gravel ridge adjacent to xeric prairie.

Vallonia gracilicosta	(176)	*Zonitoides arboreus*	(29)
Nesovitrea binneyana	(142)	*Vitrina limpida*	(15)
Gastrocopta holzingeri	(117)	*Nesovitrea electrina*	(11)
Punctum minutissimum	(97)	*Discus catskillensis*	(4)
Strobilops labyrinthica	(87)	*Discus cronkhitei*	(1)
Vertigo arthuri	(42)	Immature Pupillidae	(51)
Euconulus fulvus	(36)		

Tatlie Lake

Location: 96.3194 W., 46.9832 N.
Habitat Type: Oak Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 445

Mature Bur Oak - Black Cherry forest with thin leaf litter on hard clay soil.

Zonitoides arboreus	(94)	*Hawaiia minuscula*	(8)
Discus catskillensis	(60)	*Gastrocopta contracta*	(7)
Nesovitrea electrina	(47)	*Punctum minutissimum*	(6)
Striatura milium	(42)	*Cochlicopa lubricella*	(4)
Vitrina limpida	(30)	*Vallonia gracilicosta*	(4)
Vallonia perspectiva	(29)	*Euconulus fulvus*	(2)
Carychium exile	(24)	*Gastrocopta pentodon*	(2)
Nesovitrea binneyana	(13)	*Vallonia pulchella*	(2)
Gastrocopta tappaniana	(10)	Immature *Vallonia*	(53)
Discus cronkhitei	(8)		

Clearwater County

Alida South

Location: 95.2261 W., 47.3827 N.
Habitat Type: Black Spruce Wetland
Richness: 19

Habitat Group: Lowland Forest
Total Abundance: 557

Rich Black Spruce-Tamarack swamp forest with dense sedge-moss groundlayer.

Carychium exiguum	(137)	*Euconulus alderi*	(10)
Nesovitrea electrina	(61)	*Vertigo nylanderi*	(9)
Striatura milium	(50)	*Zonitoides arboreus*	(8)
Strobilops labyrinthica	(41)	*Punctum* n.sp.	(6)
Vertigo elatior	(30)	*Columella simplex*	(5)
Gastrocopta tappaniana	(29)	*Nesovitrea binneyana*	(3)
Discus catskillensis	(22)	*Deroceras laeve*	(2)
Striatura exigua	(21)	*Vertigo cristata*	(2)
Euconulus fulvus	(18)	*Discus cronkhitei*	(1)
Catinella avara	(14)	Immature Pupillidae	(88)

Alida West

Location: 95.3469 W., 47.3706 N.
Habitat Type: Oak Forest
Richness: 12

Habitat Group: Upland Forest
Total Abundance: 166

Upland Red Oak, Bur Oak, Aspen, Basswood with thin leaf litter over hard clay soil.

Strobilops labyrinthica	(42)	*Zonitoides arboreus*	(10)
Nesovitrea binneyana	(38)	*Euconulus fulvus*	(5)
Carychium exile	(18)	*Columella simplex*	(3)
Cochlicopa lubricella	(18)	*Nesovitrea electrina*	(3)
Striatura exigua	(15)	*Helicodiscus parallelus*	(1)
Striatura milium	(12)	Immature *Vallonia*	(1)

Bagley Lake

Location: 95.2430 W., 47.7614 N.
Habitat Type: Fen
Richness: 9

Habitat Group: Lowland Grassland
Total Abundance: 126

Floating acid shoreline sedge mat with Wild Calla, Bog Birch.

Vertigo ovata	(89)	*Oxyloma retusa*	(4)
Zonitoides nitidus	(9)	*Punctum minutissimum*	(2)
Carychium exiguum	(5)	*Hawaiia minuscula*	(1)
Euconulus alderi	(5)	Immature Pupillidae	(7)
Nesovitrea electrina	(4)		

Clearbrook School Forest 1

Location: 95.4294 47.7217
Habitat Type: Black Ash Wetland
Richness: 21

Habitat Group: Lowland Forest
Total Abundance: 523

Rich, lowland Black Ash-Balsam forest with dense herb groundlayer.

Carychium exile	(124)	*Euconulus alderi*	(6)
Carychium exiguum	(84)	*Strobilops labyrinthica*	(6)
Zonitoides nitidus	(84)	*Nesovitrea binneyana*	(5)
Hawaiia minuscula	(71)	*Striatura exigua*	(4)
Nesovitrea electrina	(62)	*Euconulus fulvus*	(2)
Cochlicopa lubrica	(58)	*Anguispira alternata*	(1)
Vallonia pulchella	(28)	*Gastrocopta pentodon*	(1)
Discus catskillensis	(25)	*Vertigo elatior*	(1)
Striatura milium	(23)	*Vertigo nylanderi*	(1)
Vitrina limpida	(20)	*Vertigo paradoxa*	(1)
Zonitoides arboreus	(12)	Immature Pupillidae	(3)
Helicodiscus parallelus	(8)	Immature *Vallonia*	(1)

Clearbrook School Forest 2

Location: 95.4267 W., 47.7231 N.
Habitat Type: Fen
Richness: 14

Habitat Group: Lowland Grassland
Total Abundance: 503

Leaf litter under Shrubby Cinquefoil and low vegetation of wet fen mat with *Scirpus cespitosus* and *Rhynchospora capillacea*.

Carychium exiguum	(108)	*Vallonia gracilicosta*	(14)
Strobilops labyrinthica	(67)	*Vertigo nylanderi*	(14)
Catinella avara	(53)	*Oxyloma retusa*	(12)
Nesovitrea electrina	(41)	*Vertigo milium*	(5)
Punctum n.sp.	(38)	*Vertigo morsei*	(3)
Euconulus alderi	(32)	*Zonitoides arboreus*	(2)
Gastrocopta tappaniana	(32)	Immature Pupillidae	(64)
Vertigo elatior	(18)		

Clearbrook School Forest 3

Location: 95.4276 W., 47.7236 N.
Habitat Type: Black Spruce Wetland
Richness: 22

Habitat Group: Lowland Forest
Total Abundance: 555

Rich, lowland Black Spruce-Balsam forest with dense sedge, herb, and moss groundlayer.

Cochlicopa lubrica	(75)	*Nesovitrea binneyana*	(15)
Carychium exile	(58)	*Helicodiscus parallelus*	(11)
Discus catskillensis	(58)	*Vertigo elatior*	(10)
Hawaiia minuscula	(56)	*Columella simplex*	(6)
Striatura exigua	(51)	*Gastrocopta tappaniana*	(3)
Zonitoides arboreus	(43)	***Vertigo nylanderi***	**(3)**
Striatura milium	(41)	*Cochlicopa lubricella*	(2)
Nesovitrea electrina	(34)	*Strobilops affinis*	(1)
Euconulus alderi	(26)	Immature Pupillidae	(9)
Strobilops labyrinthica	(26)	Immature Succineidae	(2)
Punctum minutissimum	(24)	Immature *Vallonia*	(1)

Height of Land Road

Location: 95.4963 47.2299
Habitat Type: Aspen Forest
Richness: 17

Habitat Group: Upland Forest
Total Abundance: 928

Small mature Aspen-Sugar Maple-Basswood forest remnant surround by clearcut forest.

Discus catskillensis	(144)	*Gastrocopta pentodon*	(21)
Strobilops labyrinthica	(140)	*Cochlicopa lubricella*	(9)
Carychium exile	(137)	*Helicodiscus parallelus*	(9)
Striatura exigua	(121)	*Columella simplex*	(8)
Zonitoides arboreus	(110)	*Gastrocopta contracta*	(7)
Striatura milium	(89)	*Hawaiia minuscula*	(5)
Nesovitrea binneyana	(52)	***Vertigo arthuri***	**(4)**
Punctum minutissimum	(26)	*Discus cronkhitei*	(1)
Euconulus fulvus	(22)	Immature Pupillidae	(23)

Iron Springs SNA

Location: 95.2515 W., 47.2533 N.
Habitat Type: Tamarack Wetland
Richness: 16

Habitat Group: Lowland Forest
Total Abundance: 303

Cold Tamarack swamp forest with dense sedge-moss groundcover.

Carychium exiguum	(70)	*Catinella avara*	(11)
Strobilops labyrinthica	(56)	*Striatura milium*	(10)

Nesovitrea electrina	(29)	***Vertigo nylanderi***	**(6)**
Gastrocopta tappaniana	(21)	*Columella simplex*	(3)
Zonitoides arboreus	(19)	*Punctum minutissimum*	(3)
Discus cronkhitei	(17)	*Deroceras laeve*	(2)
Striatura exigua	(15)	*Vertigo ovata*	(2)
Euconulus alderi	(12)	Immature Pupillidae	(15)
Vertigo elatior	(12)		

Lake Itasca State Park: Bear Paw Point

Location: 95.2010 W., 47.2190 N.
Habitat Type: Maple-Basswood Forest
Richness: 20

Habitat Group: Upland Forest
Total Abundance: 3096

Old-growth Basswood-Ash-Elm-Paper Birch forest with very thick leaf litter.

Punctum minutissimum	(742)	*Gastrocopta contracta*	(37)
Gastrocopta holzingeri	(466)	*Euconulus fulvus*	(29)
Hawaiia minuscula	(297)	*Nesovitrea binneyana*	(26)
Carychium exile	(250)	***Vertigo arthuri***	**(23)**
Vallonia gracilicosta	(134)	*Anguispira alternata*	(13)
Gastrocopta pentodon	(101)	*Helicodiscus parallelus*	(11)
Cochlicopa lubricella	(96)	*Columella simplex*	(10)
Strobilops labyrinthica	(89)	***Vertigo bollesiana***	**(1)**
Vallonia perspectiva	(89)	*Vertigo gouldi*	(1)
Zonitoides arboreus	(75)	Immature *Vallonia*	(379)
Striatura milium	(45)	Immature Pupillidae	(182)

Lake Itasca State Park: Bear Paw Point East

Location: 95.1950 W., 47.2200 N.
Habitat Type: Black Ash Wetland
Richness: 25

Habitat Group: Lowland Forest
Total Abundance: 1091

Rich, mature Black Ash-Tamarack swamp forest with dense sedge-moss grounlayer on east side of Bear Paw Point.

Carychium exiguum	(215)	*Hawaiia minuscula*	(21)
Strobilops labyrinthica	(138)	***Vertigo nylanderi***	**(20)**
Carychium exile	(125)	*Nesovitrea binneyana*	(18)
Vallonia gracilicosta	(76)	*Helicodiscus parallelus*	(13)
Gastrocopta tappaniana	(63)	*Punctum* n.sp.	(10)
Nesovitrea electrina	(58)	*Zonitoides arboreus*	(10)
Punctum minutissimum	(46)	*Catinella avara*	(7)

Striatura exigua	(45)	*Cochlicopa lubricella*	(6)
Euconulus alderi	(41)	*Gastrocopta pentodon*	(2)
Striatura milium	(37)	*Columella simplex*	(1)
Discus catskillensis	(29)	*Deroceras laeve*	(1)
Vertigo elatior	(23)	*Vertigo cristata*	(1)
Gastrocopta contracta	(22)	Immature Pupillidae	(66)

Lake Itasca State Park: Bear Paw Point West

Location: 95.1975 W., 47.2233 N.
Habitat Type: Black Ash Wetland
Richness: 21

Habitat Group: Lowland Forest
Total Abundance: 328

Mature, wet Black Ash swamp forest near western shore of Bear Paw Point.

Carychium exiguum	(168)	*Striatura exigua*	(5)
Carychium exile	(23)	*Discus cronkhitei*	(4)
Nesovitrea electrina	(18)	*Gastrocopta tappaniana*	(4)
Hawaiia minuscula	(14)	*Gastrocopta contracta*	(3)
Strobilops labyrinthica	(14)	*Helicodiscus parallelus*	(2)
Oxyloma retusa	(13)	***Vertigo arthuri***	(2)
Vertigo ovata	(11)	*Zonitoides arboreus*	(2)
Cochlicopa lubrica	(10)	*Cochlicopa lubricella*	(1)
Striatura milium	(10)	*Punctum minutissimum*	(1)
Vertigo elatior	(9)	***Vertigo nylanderi***	(1)
Euconulus alderi	(6)	Immature Pupillidae	(7)

Lake Itasca State Park: Boat Ramp

Location: 95.1980 47.2333
Habitat Type: Lakeshore
Richness: 15

Habitat Group: Upland Forest
Total Abundance: Field Sieve

Anguispira alternata
Catinella avara
Discus cronkhitei
Euconulus fulvus
Gastrocopta holzingeri
Hawaiia minuscula
Punctum minutissimum
Pupilla muscorum
Vallonia costata
Vallonia gracilicosta
Vallonia pulchella
Vertigo arthuri
Vertigo pygmaea
Vitrina limpida
Zonitoides arboreus

Lake Itasca State Park: Disturbed old field

Location: 95.1872 W., 47.2282 N.
Habitat Type: Old Field
Richness: 10

Habitat Group: Upland Grassland
Total Abundance: Field Sieve

Columella simplex
Gastrocopta abbreviata
Gastrocopta holzingeri
Gastrocopta tappaniana
Nesovitrea electrina
Punctum minutissimum
Vallonia costata
Vallonia pulchella
Vertigo arthuri
Vertigo pygmaea

Lake Itasca State Park: Peace Pipe Vista

Location: 95.1752 47.2089
Habitat Type: Red Pine Forest
Richness: 13

Habitat Group: Upland Forest
Total Abundance: 632

Deep leaf litter under upland old-growth Red and White Pine grove.

Vertigo cristata	(100)	*Discus catskillensis*	(27)
Striatura milium	(95)	*Carychium exile*	(15)
Striatura exigua	(68)	*Euconulus fulvus*	(8)
Punctum minutissimum	(59)	*Columella simplex*	(3)
Zonitoides arboreus	(50)	*Gastrocopta tappaniana*	(1)
Strobilops labyrinthica	(46)	*Helicodiscus parallelus*	(1)
Nesovitrea binneyana	(32)	Immature Pupillidae	(127)

Long Lake

Location: 95.2368 W., 47.7807 N.
Habitat Type: Aspen Forest
Richness: 14

Habitat Group: Upland Forest
Total Abundance: 637

Aspen, Oak, Jack Pine forest with deep leaf litter over sandy soil.

Striatura milium	(146)	*Punctum minutissimum*	(16)
Nesovitrea binneyana	(141)	*Columella simplex*	(11)
Strobilops labyrinthica	(102)	*Gastrocopta pentodon*	(8)
Discus catskillensis	(61)	***Vertigo arthuri***	**(5)**
Zonitoides arboreus	(52)	*Discus cronkhitei*	(3)
Cochlicopa lubricella	(38)	*Helicodiscus parallelus*	(1)
Euconulus fulvus	(22)	Immature Pupillidae	(14)
Nesovitrea electrina	(17)		

Red Lake Trail WMA 1

Location: 95.3178 47.6272
Habitat Type: Aspen Forest
Richness: 16

Habitat Group: Upland Forest
Total Abundance: 632

Mature Aspen, Bur Oak, Red Oak, Ash forest with moderately deep leaf litter.

Strobilops labyrinthica	(114)	*Columella simplex*	(21)
Striatura milium	(111)	*Zonitoides arboreus*	(12)
Nesovitrea binneyana	(102)	***Vertigo arthuri***	**(8)**
Euconulus fulvus	(59)	*Vitrina limpida*	(7)
Discus catskillensis	(57)	*Gastrocopta pentodon*	(5)
Nesovitrea electrina	(32)	*Gastrocopta contracta*	(1)
Carychium exile	(29)	*Vallonia gracilicosta*	(1)
Cochlicopa lubricella	(28)	Immature Pupillidae	(19)
Punctum minutissimum	(26)		

Red Lake Trail WMA 2

Location: 95.3057 W., 47.6212N.
Habitat Type: Aspen Forest
Richness: 17

Habitat Group: Upland Forest
Total Abundance: 1316

Young, mesic Aspen, Ash, Balsam, White Spruce with deep leaf litter.

Strobilops labyrinthica	(249)	*Vallonia gracilicosta*	(34)
Nesovitrea binneyana	(204)	***Vertigo arthuri***	**(22)**
Carychium exile	(189)	*Gastrocopta pentodon*	(18)
Discus catskillensis	(140)	*Columella simplex*	(14)
Striatura milium	(128)	*Gastrocopta tappaniana*	(14)
Punctum minutissimum	(77)	*Zonitoides arboreus*	(11)
Cochlicopa lubricella	(73)	*Helicodiscus parallelus*	(6)
Nesovitrea electrina	(46)	*Discus cronkhitei*	(1)
Euconulus fulvus	(37)	Immature Pupillidae	(53)

Tamarack Lake 1

Location: 95.4492 W., 47.4363 N.
Habitat Type: Tamarack Wetland
Richness: 8

Habitat Group: Lowland Forest
Total Abundance: 129

Very wet Tamarack, Alder, Bog Birch swamp forest.

Carychium exiguum	(45)	*Vertigo elatior*	(4)
Nesovitrea electrina	(25)	*Euconulus alderi*	(1)
Gastrocopta tappaniana	(10)	Immature Pupillidae	(30)
Striatura milium	(7)	Immature Succineidae	(3)
Catinella avara	(4)		

Tamarack Lake 2

Location: 95.4460 W., 47.4388 N.
Habitat Type: Aspen Forest
Richness: 17

Habitat Group: Upland Forest
Total Abundance: 758

Low Aspen-Alder forest with deep leaf litter.

Carychium exile	(112)	*Columella simplex*	(26)
Cochlicopa lubricella	(96)	*Discus catskillensis*	(22)
Strobilops labyrinthica	(87)	*Zonitoides arboreus*	(22)
Striatura milium	(79)	*Vitrina limpida*	(8)
Nesovitrea electrina	(62)	***Vertigo arthuri***	**(6)**
Punctum minutissimum	(62)	*Anguispira alternata*	(1)
Euconulus fulvus	(55)	*Discus cronkhitei*	(1)
Nesovitrea binneyana	(47)	*Vertigo elatior*	(1)
Gastrocopta tappaniana	(29)	Immature Pupillidae	(42)

Upper Rice Lake

Location: 95.2969 W., 47.3810 N.
Habitat Type: Lakeshore
Richness: 17

Habitat Group: Upland Forest
Total Abundance: Field Sieve

Leaf litter under shrubs and sedges along sandy lakeshore margin.

Carychium exile	*Nesovitrea electrina*
Columella simplex	*Punctum minutissimum*
Discus cronkhitei	*Striatura milium*
Euconulus fulvus	*Vallonia gracilicosta*
Gastrocopta holzingeri	*Vallonia pulchella*
Gastrocopta pentodon	***Vertigo arthuri***
Gastrocopta tappaniana	*Vitrina limpida*
Helicodiscus parallelus	*Zonitoides arboreus*
Nesovitrea binneyana	

Wild Rice River

Location: 95.4386 W., 47.3099 N.
Habitat Type: Jack Pine Forest
Richness: 15

Habitat Group: Upland Forest
Total Abundance: 327

Deep leaf litter of dry-mesic Jack Pine - Balsam forest over sandy soil.

Striatura milium	(96)	*Euconulus fulvus*	(7)
Nesovitrea binneyana	(63)	*Zonitoides arboreus*	(7)
Strobilops labyrinthica	(48)	*Carychium exile*	(4)
Punctum minutissimum	(24)	*Columella simplex*	(4)
Discus catskillensis	(17)	*Helicodiscus parallelus*	(1)
Nesovitrea electrina	(16)	***Vertigo arthuri***	(1)
Vertigo cristata	(11)	Immature Pupillidae	(18)
Cochlicopa lubricella	(10)		

Hubbard County

Badoura State Forest

Location: 94.7229 W., 46.8505 N.
Habitat Type: Aspen Forest
Richness: 15

Habitat Group: Upland Forest
Total Abundance: 643

Mesic Aspen forest with dense Hazel understory and abundant Bracken Fern.

Strobilops labyrinthica	(189)	*Zonitoides arboreus*	(18)
Striatura milium	(105)	*Euconulus fulvus*	(17)
Gastrocopta tappaniana	(68)	*Punctum minutissimum*	(14)
Striatura exigua	(59)	*Vitrina limpida*	(13)
Nesovitrea binneyana	(50)	***Vertigo arthuri***	(8)
Columella simplex	(29)	*Carychium exile*	(2)
Discus catskillensis	(25)	Immature Pupillidae	(24)
Nesovitrea electrina	(20)	Immature *Cochlicopa*	(2)

Brown Lake

Location: 94.9671 W., 47.2748 N.
Habitat Type: Jack Pine Forest
Richness: 8

Habitat Group: Upland Forest
Total Abundance: 172

Deep deciduous litter accumulations under hazel scrub in xeric, sandy Jack Pine savanna.

Nesovitrea binneyana	(32)	*Punctum minutissimum*	(8)
Striatura milium	(31)	*Zonitoides arboreus*	(8)
Vertigo cristata	(19)	*Columella simplex*	(3)
Strobilops labyrinthica	(16)	Immature Pupillidae	(43)
Euconulus fulvus	(12)		

Crow Wing Chain WMA

Location: 94.8722 W., 46.8316 N.
Habitat Type: Aspen Forest
Richness: 13
Habitat Group: Upland Forest
Total Abundance: 736

Mature Aspen-Paper Birch forest with Hazel understory with deep leaf litter and sandy soil.

Nesovitrea binneyana	(169)	*Euconulus fulvus*	(27)
Striatura milium	(156)	*Columella simplex*	(22)
Strobilops labyrinthica	(142)	*Nesovitrea electrina*	(18)
Zonitoides arboreus	(61)	*Helicodiscus parallelus*	(6)
Punctum minutissimum	(57)	***Vertigo arthuri***	**(2)**
Discus catskillensis	(36)	*Vallonia costata*	(1)
Cochlicopa lubricella	(27)	Immature Pupillidae	(12)

Dead Creek

Location: 95.0113 W., 47.3697 N.
Habitat Type: Oak Forest
Richness: 11
Habitat Group: Upland Forest
Total Abundance: 178

Upland Red Oak-Bur Oak-Aspen forest with thin leaf litter over hard clay soil.

Strobilops labyrinthica	(52)	*Nesovitrea electrina*	(6)
Nesovitrea binneyana	(37)	*Columella simplex*	(4)
Striatura milium	(30)	*Carychium exile*	(2)
Zonitoides arboreus	(21)	*Gastrocopta pentodon*	(1)
Discus catskillensis	(16)	Immature *Cochlicopa*	(2)
Euconulus fulvus	(7)		

Fontenac Lake 1

Location: 94.9791 W., 47.3559 N.
Habitat Type: Red Pine Forest
Richness: 15
Habitat Group: Upland Forest
Total Abundance: 751

Mature upland Red Pine, Aspen, Balsam, Oak forest remnant.

Nesovitrea electrina	(139)	*Nesovitrea binneyana*	(24)
Striatura milium	(123)	*Cochlicopa lubricella*	(12)
Discus catskillensis	(108)	*Columella simplex*	(11)
Carychium exile	(86)	*Vertigo cristata*	(5)
Punctum minutissimum	(65)	***Vertigo arthuri***	(3)
Strobilops labyrinthica	(54)	*Striatura exigua*	(2)
Euconulus fulvus	(46)	*Carychium exiguum*	(1)
Zonitoides arboreus	(36)	Immature Pupillidae	(36)

Fontenac Lake 2

Location: 94.9804 W., 47.3550 N.
Habitat Type: Black Ash Wetland
Richness: 23

Habitat Group: Lowland Forest
Total Abundance: 1615

Lowland, mature Black Ash forest with abundant fern groundcover.

Punctum minutissimum	(280)	*Gastrocopta tappaniana*	(27)
Carychium exile	(233)	*Helicodiscus parallelus*	(25)
Cochlicopa lubricella	(142)	*Striatura exigua*	(18)
Striatura milium	(138)	*Euconulus alderi*	(11)
Nesovitrea electrina	(104)	*Nesovitrea binneyana*	(11)
Gastrocopta contracta	(91)	***Vertigo arthuri***	(10)
Zonitoides arboreus	(63)	*Euconulus fulvus*	(8)
Hawaiia minuscula	(61)	*Columella simplex*	(7)
Gastrocopta pentodon	(59)	*Vertigo elatior*	(4)
Strobilops labyrinthica	(56)	***Vertigo nylanderi***	(3)
Carychium exiguum	(47)	*Vitrina limpida*	(3)
Discus cronkhitei	(41)	Immature Pupillidae	(173)

Kabekona Creek

Location: 94.9379 W., 47.2691 N.
Habitat Type: Tamarack Wetland
Richness: 21

Habitat Group: Lowland Forest
Total Abundance: 500

Rich Tamarack, Black Spruce, Paper Birch swamp forest with dense sedge-moss ground layer.

Carychium exile	(85)	*Euconulus fulvus*	(14)
Carychium exiguum	(64)	*Punctum minutissimum*	(12)
Strobilops labyrinthica	(52)	*Vertigo elatior*	(11)
Nesovitrea binneyana	(51)	*Euconulus alderi*	(7)
Striatura milium	(38)	*Punctum* n.sp.	(7)

Nesovitrea electrina	(37)	*Discus cronkhitei*	(3)
Striatura exigua	(25)	*Columella simplex*	(2)
Cochlicopa lubricella	(24)	*Vertigo paradoxa*	(1)
Discus catskillensis	(21)	Immature Pupillidae	(10)
Vertigo nylanderi	(20)	Immature Succineidae	(1)
Zonitoides arboreus	(15)		

Kabekona Forest Road

Location: 94.7527 W., 47.1126 N.
Habitat Type: Paper Birch Forest
Richness: 13
Habitat Group: Upland Forest
Total Abundance: 173

Paper Birch-Sugar Maple forest on steep northeast-facing slope above pothole lake.

Strobilops labyrinthica	(44)	*Cochlicopa lubricella*	(4)
Striatura exigua	(38)	*Columella simplex*	(3)
Striatura milium	(27)	*Nesovitrea electrina*	(2)
Carychium exile	(23)	*Euconulus fulvus*	(1)
Discus catskillensis	(14)	*Gastrocopta pentodon*	(1)
Zonitoides arboreus	(9)	*Helicodiscus parallelus*	(1)
Nesovitrea binneyana	(6)		

Upper Twin Lake 1

Location: 95.0379 W., 46.8192 N.
Habitat Type: Red Pine Forest
Richness: 11
Habitat Group: Upland Forest
Total Abundance: 250

Mature Red Pine, Red Oak, Bur Oak forest with deep leaf litter over sandy soil.

Striatura milium	(94)	*Columella simplex*	(7)
Nesovitrea binneyana	(35)	*Helicodiscus parallelus*	(6)
Discus catskillensis	(34)	*Euconulus fulvus*	(3)
Strobilops labyrinthica	(30)	*Zonitoides arboreus*	(3)
Nesovitrea electrina	(15)	*Punctum minutissimum*	(1)
Vertigo cristata	(9)	Immature Pupillidae	(13)

Upper Twin Lake 2

Location: 95.0301 W., 46.8299 N.
Habitat Type: Black Ash Wetland
Richness: 6
Habitat Group: Lowland Forest
Total Abundance: 65

Floodplain Black Ash forest with thin leaf litter over hard clay soil.

Cochlicopa lubrica	(38)	*Euconulus fulvus*	(2)
Nesovitrea electrina	(16)	*Zonitoides arboreus*	(2)
Carychium exile	(5)	*Zonitoides nitidus*	(2)

Kittson County

Beaches WMA 1

Location: 96.4253 W., 48.8440 N.
Habitat Type: Aspen Forest
Richness: 11

Habitat Group: Upland Forest
Total Abundance: 889

Mesic Aspen, Balsam Poplar, Dogwood forest surrounded by open wetland.

Punctum minutissimum	(307)	*Nesovitrea binneyana*	(29)
Carychium exile	(183)	*Punctum* n.sp.	(20)
Gastrocopta tappaniana	(149)	*Nesovitrea electrina*	(13)
Vallonia gracilicosta	(103)	*Zonitoides arboreus*	(6)
Cochlicopa lubricella	(46)	Immature Pupillidae	(4)
Euconulus fulvus	(29)		

Beaches WMA 2

Location: 96.4261 W., 48.8442 N.
Habitat Type: Calcareous Meadow
Richness: 8

Habitat Group: Lowland Grassland
Total Abundance: 411

Low sedge growth in calcareous wet meadow.

Nesovitrea electrina	(135)	*Zonitoides arboreus*	(15)
Gastrocopta tappaniana	(64)	*Catinella avara*	(6)
Punctum minutissimum	(57)	*Vertigo elatior*	(2)
Euconulus alderi	(46)	Immature Pupillidae	(59)
Vertigo ovata	(27)		

Halma Roadside

Location: 96.6719 W., 48.6596 N.
Habitat Type: Sedge Meadow
Richness: 23

Habitat Group: Lowland Grassland
Total Abundance: 2097

Mesic roadside ditch dominated with sedges

Carychium exile	(347)	***Vertigo arthuri***	**(24)**
Hawaiia minuscula	(315)	*Euconulus fulvus*	(23)
Cochlicopa lubrica	(298)	*Vertigo elatior*	(14)
Punctum minutissimum	(285)	*Vitrina limpida*	(13)
Carychium exiguum	(218)	*Gastrocopta holzingeri*	(12)
Gastrocopta contracta	(98)	*Euconulus alderi*	(11)
Discus catskillensis	(92)	*Succinea ovalis*	(10)
Punctum n.sp.	(92)	*Nesovitrea binneyana*	(4)
Nesovitrea electrina	(47)	*Zonitoides arboreus*	(4)
Vallonia gracilicosta	(34)	*Deroceras laeve*	(1)
Vertigo ovata	(26)	*Discus cronkhitei*	(1)
Gastrocopta tappaniana	(25)	Immature Pupillidae	(103)

Halma Swamp WMA

Location: 96.6729 W., 48.6591 N.
Habitat Type: Black Ash Wetland
Richness: 27

Habitat Group: Lowland Forest
Total Abundance: 4232

Mature lowland Black Ash, Elm, Box Elder forest with deep leaf litter.

Carychium exile	(919)	*Anguispira alternata*	(27)
Cochlicopa lubrica	(773)	*Euconulus fulvus*	(24)
Vallonia gracilicosta	(485)	*Zonitoides arboreus*	(20)
Discus cronkhitei	(484)	*Gastrocopta pentodon*	(15)
Nesovitrea electrina	(362)	*Nesovitrea binneyana*	(15)
Punctum minutissimum	(265)	*Vitrina limpida*	(13)
Carychium exiguum	(225)	***Catinella exile***	**(6)**
Gastrocopta contracta	(118)	*Punctum* n.sp.	(3)
Gastrocopta tappaniana	(115)	***Vertigo arthuri***	**(3)**
Striatura milium	(48)	*Vertigo elatior*	(3)
Hawaiia minuscula	(47)	*Columella simplex*	(1)
Strobilops labyrinthica	(39)	*Deroceras laeve*	(1)
Succinea ovalis	(38)	*Vertigo ovata*	(1)
Cochlicopa lubricella	(28)	Immature Pupillidae	(154)

Lake Bronson NW

Location: 96.6947 W., 48.7673 N.
Habitat Type: Calcareous Meadow
Richness: 19

Habitat Group: Lowland Grassland
Total Abundance: 1135

Low vegetation of open, moist roadside and railroad right-of-way with exposed mineral soil.

Vertigo elatior	(228)	*Gastrocopta holzingeri*	(10)
Gastrocopta tappaniana	(180)	*Gastrocopta similis*	(9)
Carychium exiguum	(172)	*Vertigo milium*	(7)
Nesovitrea electrina	(106)	*Deroceras laeve*	(6)
Euconulus alderi	(73)	*Hawaiia minuscula*	(6)
Cochlicopa lubricella	(24)	*Zonitoides arboreus*	(5)
Vallonia gracilicosta	(23)	*Euconulus fulvus*	(1)
Gastrocopta contracta	(21)	*Strobilops labyrinthica*	(1)
Punctum minutissimum	(21)	*Vitrina limpida*	(1)
Catinella avara	(19)	Immature Pupillidae	(222)

Lake Bronson State Park 1

Location: 96.5757 W., 48.7189 N.
Habitat Type: Aspen Forest
Richness: 19

Habitat Group: Upland Forest
Total Abundance: 1340

Young, mesic Aspen grove with deep leaf litter.

Punctum minutissimum	(292)	*Discus catskillensis*	(14)
Vallonia gracilicosta	(216)	*Vertigo arthuri*	(13)
Gastrocopta pentodon	(211)	*Nesovitrea electrina*	(11)
Vitrina limpida	(132)	*Euconulus alderi*	(7)
Nesovitrea binneyana	(100)	*Gastrocopta holzingeri*	(4)
Striatura milium	(84)	*Cochlicopa lubricella*	(3)
Zonitoides arboreus	(59)	*Vertigo ovata*	(3)
Euconulus fulvus	(48)	*Hawaiia minuscula*	(2)
Gastrocopta tappaniana	(41)	*Deroceras laeve*	(1)
Strobilops labyrinthica	(31)	Immature Pupillidae	(68)

Lake Bronson State Park 2

Location: 96.6360 W., 48.7229 N.
Habitat Type: Oak Forest
Richness: 26

Habitat Group: Upland Forest
Total Abundance: 507

Steep north-facing Bur Oak slopes along ravine downstream from dam; leaf litter thin and soil of hard clay.

Punctum minutissimum	(59)	*Striatura milium*	(7)
Nesovitrea binneyana	(44)	*Gastrocopta holzingeri*	(6)
Cochlicopa lubrica	(42)	*Cochlicopa lubricella*	(5)
Vallonia perspectiva	(41)	*Discus cronkhitei*	(5)
Vallonia gracilicosta	(33)	*Helicodiscus parallelus*	(4)

Discus catskillensis	(32)	*Zonitoides nitidus*	(4)
Vitrina limpida	(18)	*Deroceras laeve*	(1)
Euconulus fulvus	(17)	*Gastrocopta contracta*	(1)
Nesovitrea electrina	(17)	*Gastrocopta tappaniana*	(1)
Carychium exile	(16)	*Hawaiia minuscula*	(1)
Vallonia pulchella	(12)	*Vertigo elatior*	(1)
Zonitoides arboreus	(12)	Immature *Vallonia*	(107)
Vallonia costata	(10)	Immature Pupillidae	(3)
Carychium exiguum	(7)	Immature Succineidae	(1)

Lancaster City Park

Location: 96.7976 W., 48.8666 N.
Habitat Type: Oak Forest
Richness: 18
Habitat Group: Upland Forest
Total Abundance: 490

Mature Bur Oak-Aspen forest on north-facing slope with thin leaf litter.

Strobilops labyrinthica	(116)	*Punctum minutissimum*	(7)
Nesovitrea binneyana	(111)	*Vitrina limpida*	(7)
Discus catskillensis	(64)	*Carychium exile*	(6)
Cochlicopa lubricella	(30)	*Gastrocopta tappaniana*	(4)
Zonitoides arboreus	(24)	*Vertigo arthuri*	(4)
Striatura milium	(22)	*Gastrocopta holzingeri*	(2)
Gastrocopta pentodon	(20)	*Hawaiia minuscula*	(2)
Nesovitrea electrina	(16)	*Vallonia gracilicosta*	(2)
Euconulus fulvus	(9)	Immature *Vallonia*	(30)
Vallonia perspectiva	(9)	Immature Pupillidae	(5)

Twistal Swamp

Location: 96.4475 W., 48.6279 N.
Habitat Type: Tamarack Wetland
Richness: 22
Habitat Group: Lowland Forest
Total Abundance: 2132

Open Tamarack, Willow, Black Ash swamp forest.

Carychium exile	(439)	*Gastrocopta pentodon*	(29)
Carychium exiguum	(368)	*Vertigo elatior*	(17)
Nesovitrea electrina	(345)	*Strobilops labyrinthica*	(15)
Discus catskillensis	(184)	*Discus cronkhitei*	(12)
Punctum minutissimum	(178)	*Vertigo arthuri*	(11)
Euconulus alderi	(87)	*Hawaiia minuscula*	(9)
Gastrocopta tappaniana	(77)	*Vitrina limpida*	(6)

Cochlicopa lubricella	(71)	*Catinella exile*	(1)
Vallonia gracilicosta	(63)	*Nesovitrea binneyana*	(1)
Gastrocopta contracta	(47)	Immature Pupillidae	(76)
Zonitoides arboreus	(47)	Immature Succineidae	(9)
Striatura milium	(40)		

Lake of the Woods County

Blueberry Hill

Location: 95.0404 W., 48.8002 N.
Habitat Type: Tamarack Wetland
Richness: 21

Habitat Group: Lowland Forest
Total Abundance: 278

Somewhat acidic wet-mesic Tamarack, Black Spruce, Aspen forest.

Carychium exiguum	(65)	*Nesovitrea binneyana*	(5)
Discus catskillensis	(37)	*Cochlicopa lubricella*	(4)
Striatura milium	(32)	*Carychium exile*	(2)
Punctum minutissimum	(25)	*Catinella avara*	(2)
Gastrocopta tappaniana	(18)	***Vertigo arthuri***	**(2)**
Strobilops labyrinthica	(17)	*Cochlicopa lubrica*	(1)
Nesovitrea electrina	(13)	*Deroceras laeve*	(1)
Vertigo nylanderi	**(13)**	*Discus cronkhitei*	(1)
Vertigo elatior	(10)	*Vertigo cristata*	(1)
Euconulus fulvus	(6)	Immature Pupillidae	(16)
Columella simplex	(5)	Immature Succineidae	(2)

Dave Pepin Homestead

Location: 94.8188 W., 48.4102 N.
Habitat Type: Floodplain Forest
Richness: 18

Habitat Group: Lowland Forest
Total Abundance: 498

Mature floodplain Silver Maple Green Ash forest with deep leaf litter.

Discus catskillensis	(84)	*Hawaiia minuscula*	(17)
Vallonia gracilicosta	(74)	*Anguispira alternata*	(11)
Cochlicopa lubrica	(73)	*Cochlicopa lubricella*	(10)
Carychium exile	(68)	*Euconulus fulvus*	(5)
Nesovitrea electrina	(53)	*Discus cronkhitei*	(3)
Vitrina limpida	(34)	*Nesovitrea binneyana*	(3)
Striatura milium	(21)	*Columella simplex*	(2)
Succinea ovalis	(19)	*Gastrocopta tappaniana*	(2)

Zonitoides arboreus	(18)	*Deroceras laeve*	(1)

Faunce North

Location: 94.9517 W., 48.6354 N.
Habitat Type: Tamarack Wetland
Richness: 19

Habitat Group: Lowland Forest
Total Abundance: 1222

Rich, wet-mesic Tamarack, Willow, Alder swamp forest with dense sedge-moss groundcover.

Punctum minutissimum	(312)	*Euconulus fulvus*	(31)
Carychium exile	(151)	*Vallonia gracilicosta*	(30)
Carychium exiguum	(134)	*Nesovitrea binneyana*	(21)
Striatura milium	(110)	*Vertigo elatior*	(12)
Gastrocopta tappaniana	(83)	*Columella simplex*	(9)
Strobilops labyrinthica	(57)	*Oxyloma retusa*	(6)
Nesovitrea electrina	(56)	*Cochlicopa lubrica*	(5)
Vertigo nylanderi	**(34)**	*Zonitoides arboreus*	(4)
Cochlicopa lubricella	(32)	*Deroceras laeve*	(3)
Discus catskillensis	(32)	Immature Pupillidae	(100)

Faunce South

Location: 94.9519 W., 48.5348 N.
Habitat Type: White Cedar Wetland
Richness: 12

Habitat Group: Lowland Forest
Total Abundance: 271

Wet-mesic white cedar forest with deep leaf litter.

Carychium exile	(93)	*Zonitoides arboreus*	(8)
Striatura milium	(38)	*Striatura exigua*	(5)
Punctum minutissimum	(33)	*Gastrocopta tappaniana*	(4)
Discus catskillensis	(27)	***Vertigo arthuri***	**(4)**
Nesovitrea binneyana	(16)	*Vertigo cristata*	(3)
Strobilops labyrinthica	(14)	Immature Pupillidae	(13)
Euconulus alderi	(13)		

Norris Camp

Location: 95.1742 48.6129
Habitat Type: White Cedar Wetland
Richness: 14

Habitat Group: Lowland Forest
Total Abundance: 577

Mature wet-mesic White Cedar-White Spruce forest with deep leaf litter.

Striatura milium	(137)	*Nesovitrea electrina*	(8)
Strobilops labyrinthica	(93)	*Discus catskillensis*	(6)
Punctum minutissimum	(64)	*Columella simplex*	(3)
Gastrocopta tappaniana	(46)	***Vertigo arthuri***	**(2)**
Vertigo paradoxa	**(43)**	*Carychium exile*	(1)
Nesovitrea binneyana	(42)	*Zonitoides arboreus*	(1)
Euconulus fulvus	(22)	Immature Pupillidae	(88)
Vertigo cristata	(21)		

Rapid River Road 1

Location: 94.8560 W., 48.4082 N.
Habitat Type: Aspen Forest
Richness: 16

Habitat Group: Upland Forest
Total Abundance: 704

Mature, upland Aspen forest with Beaked Hazel understory and thin leaf litter over clay soil.

Vallonia gracilicosta	(230)	*Columella simplex*	(26)
Strobilops labyrinthica	(101)	*Cochlicopa lubricella*	(20)
Nesovitrea binneyana	(92)	***Vertigo arthuri***	**(14)**
Discus catskillensis	(47)	*Zonitoides arboreus*	(14)
Carychium exile	(45)	*Succinea ovalis*	(6)
Euconulus fulvus	(39)	*Nesovitrea electrina*	(4)
Punctum minutissimum	(32)	*Discus cronkhitei*	(2)
Striatura milium	(30)	*Helicodiscus parallelus*	(2)

Rapid River Road 2

Location: 94.7405 W., 48.4320 N.
Habitat Type: Oak Forest
Richness: 19

Habitat Group: Upland Forest
Total Abundance: 450

Mature, upland Bur Oak, Ash, Aspen forest with moderately thick leaf litter.

Nesovitrea binneyana	(76)	*Cochlicopa lubricella*	(8)
Strobilops labyrinthica	(61)	*Gastrocopta tappaniana*	(8)
Cochlicopa lubrica	(55)	*Vitrina limpida*	(7)
Discus catskillensis	(49)	*Zonitoides arboreus*	(6)
Carychium exile	(47)	*Columella simplex*	(5)
Striatura milium	(47)	*Discus cronkhitei*	(2)
Euconulus fulvus	(30)	*Vallonia gracilicosta*	(2)
Striatura exigua	(23)	*Hawaiia minuscula*	(1)
Punctum minutissimum	(12)	Immature Succineidae	(1)

Nesovitrea electrina (10)

Roseau River

Location: 95.3205 W., 48.5524 N.
Habitat Type: Tamarack Wetland
Richness: 11
Habitat Group: Lowland Forest
Total Abundance: 313

Wet Tamarack swamp forest with many standing pools.

Carychium exiguum	(179)	*Columella simplex*	(4)
Striatura milium	(42)	*Euconulus alderi*	(3)
Punctum n.sp.	(38)	*Vertigo elatior*	(3)
Gastrocopta tappaniana	(8)	*Zonitoides arboreus*	(3)
Vertigo nylanderi	(7)	Immature Pupillidae	(20)
Nesovitrea electrina	(5)	Immature Succineidae	(1)

Winter Road Peatland

Location: 95.1391 W., 48.7053 N.
Habitat Type: Fen
Richness: 9
Habitat Group: Lowland Grassland
Total Abundance: 245

Leaf litter under Bog Birch-Shining Willow dominated strings in wet peatland.

Vertigo elatior	(57)	*Euconulus alderi*	(12)
Carychium exiguum	(52)	*Oxyloma retusa*	(5)
Gastrocopta tappaniana	(32)	*Vertigo ovata*	(3)
Nesovitrea electrina	(23)	*Punctum* n.sp.	(2)
Catinella avara	(20)	Immature Pupillidae	(39)

Winter Road South

Location: 95.1475 48.6306
Habitat Type: Balsam-White Spruce Forest
Richness: 15
Habitat Group: Upland Forest
Total Abundance: 334

Mesic Balsam-White Spruce forest with diverse herb and bryophyte groundlayer.

Striatura milium	(82)	*Vertigo cristata*	(10)
Nesovitrea binneyana	(58)	*Euconulus fulvus*	(9)
Discus catskillensis	(44)	*Striatura exigua*	(9)
Carychium exile	(26)	*Gastrocopta tappaniana*	(7)
Nesovitrea electrina	(19)	*Cochlicopa lubricella*	(1)

Vertigo arthuri	(12)	*Deroceras laeve*	(1)
Punctum minutissimum	(11)	*Vertigo paradoxa*	(1)
Strobilops labyrinthica	(10)	Immature Pupillidae	(34)

Zippel Bay State Park 1

Location: 94.8428 W., 48.8664 N.
Habitat Type: Black Ash Forest
Richness: 16

Habitat Group: Lowland Forest
Total Abundance: 588

Sandy levee dominated by Ash-Willow forest along lakeshore

Vallonia gracilicosta	(220)	*Euconulus fulvus*	(12)
Cochlicopa lubricella	(119)	*Punctum minutissimum*	(12)
Gastrocopta tappaniana	(76)	*Nesovitrea binneyana*	(5)
Succinea ovalis	(37)	*Catinella avara*	(4)
Nesovitrea electrina	(28)	*Zonitoides nitidus*	(3)
Cochlicopa lubrica	(27)	*Carychium exiguum*	(2)
Discus cronkhitei	(25)	*Zonitoides arboreus*	(2)
Vertigo arthuri	(15)	*Deroceras laeve*	(1)

Zippel Bay State Park 2

Location: 94.8375 W., 48.8580 N.
Habitat Type: Paper Birch Forest
Richness: 12

Habitat Group: Upland Forest
Total Abundance: 296

Mature Paper Birch forest with Bracken groundcover and deep leaf litter.

Strobilops labyrinthica	(117)	*Helicodiscus parallelus*	(7)
Nesovitrea binneyana	(92)	*Nesovitrea electrina*	(7)
Striatura milium	(23)	*Cochlicopa lubricella*	(6)
Discus catskillensis	(14)	*Zonitoides arboreus*	(6)
Punctum minutissimum	(12)	*Succinea ovalis*	(3)
Euconulus fulvus	(7)	*Columella simplex*	(2)

Zippel Bay State Park 3

Location: 94.8461 W., 48.8473 N.
Habitat Type: Aspen Forest
Richness: 14

Habitat Group: Upland Forest
Total Abundance: 238

Mature upland Aspen forest with thin leaf litter

Strobilops labyrinthica	(64)	*Discus catskillensis*	(5)
Striatura milium	(44)	*Columella simplex*	(2)
Nesovitrea binneyana	(37)	*Succinea ovalis*	(2)
Discus cronkhitei	(27)	*Euconulus fulvus*	(1)
Cochlicopa lubricella	(25)	*Gastrocopta tappaniana*	(1)
Punctum minutissimum	(11)	*Vertigo arthuri*	(1)
Nesovitrea electrina	(9)	Immature Pupillidae	(3)
Zonitoides arboreus	(6)		

Zippel Bay West

Location: 94.9374 W., 48.8437 N.
Habitat Type: White Cedar Wetland
Richness: 16
Habitat Group: Lowland Forest
Total Abundance: 288

Mature, mesic, cold White Cedar-Black Spruce swamp forest with deep leaf litter.

Carychium exile	(111)	*Striatura milium*	(6)
Discus catskillensis	(59)	*Carychium exiguum*	(5)
Nesovitrea electrina	(17)	*Strobilops labyrinthica*	(5)
Vallonia gracilicosta	(16)	*Euconulus alderi*	(3)
Cochlicopa lubricella	(14)	*Gastrocopta tappaniana*	(3)
Discus cronkhitei	(13)	*Columella simplex*	(2)
Punctum minutissimum	(13)	*Vertigo paradoxa*	(2)
Nesovitrea binneyana	(7)	Immature Pupillidae	(5)
Zonitoides arboreus	(7)		

Mahnomen County

Dittmer WMA

Location: 96.0528 W., 47.4122 N.
Habitat Type: Aspen Forest
Richness: 11
Habitat Group: Upland Forest
Total Abundance: 858

Upland Aspen forest degraded by burning and tree removal.

Punctum minutissimum	(231)	*Euconulus fulvus*	(14)
Gastrocopta holzingeri	(132)	*Discus cronkhitei*	(8)
Vitrina limpida	(113)	*Hawaiia minuscula*	(8)
Gastrocopta tappaniana	(48)	*Vallonia perspectiva*	(8)
Vallonia gracilicosta	(42)	Immature *Vallonia*	(127)
Nesovitrea electrina	(40)	Immature Pupillidae	(67)
Zonitoides arboreus	(20)		

Eastlund Lake

Location: 95.7847 47.4447
Habitat Type: Mesic Prairie
Richness: 12

Habitat Group: Upland Grassland
Total Abundance: 490

Leaf litter under hazel thickets on dry-mesic prairie.

Punctum minutissimum	(137)	*Gastrocopta similis*	(21)
Vallonia gracilicosta	(66)	*Vallonia perspectiva*	(11)
Nesovitrea electrina	(61)	*Zonitoides arboreus*	(8)
Cochlicopa lubricella	(37)	*Catinella avara*	(6)
Gastrocopta holzingeri	(36)	*Helicodiscus parallelus*	(3)
Hawaiia minuscula	(35)	Immature Vallonia	(39)
Euconulus fulvus	(30)		

Mahnomen North

Location: 95.9689 w., 47.3574 N.
Habitat Type: Mesic Prairie
Richness: 16

Habitat Group: Upland Grassland
Total Abundance: 806

Mesic-wet remant prairie along railroad.

Hawaiia minuscula	(162)	*Vallonia gracilicosta*	(6)
Catinella avara	(160)	*Vallonia perspectiva*	(6)
Vertigo milium	(158)	*Zonitoides arboreus*	(3)
Vallonia pulchella	(94)	*Oxyloma retusa*	(2)
Gastrocopta tappaniana	(36)	*Vitrina limpida*	(2)
Nesovitrea electrina	(35)	*Helicodiscus parallelus*	(1)
Vertigo ovata	(30)	*Vallonia costata*	(1)
Punctum minutissimum	(23)	Immature *Vallonia*	(63)
Euconulus fulvus	(14)	Immature Pupillidae	(10)

Mike Lake

Location: 95.6965 W., 47.1862 N.
Habitat Type: Tamarack Wetland
Richness: 20

Habitat Group: Lowland Forest
Total Abundance: 329

Rich Tamarack, Black Ash, Alder swamp forest with sedge ground layer.

Carychium exile	(74)	*Striatura exigua*	(4)
Strobilops labyrinthica	(49)	*Columella simplex*	(3)

Carychium exiguum	(43)	***Vertigo arthuri***	**(3)**
Discus catskillensis	(31)	*Discus cronkhitei*	(2)
Nesovitrea electrina	(29)	*Euconulus fulvus*	(2)
Striatura milium	(24)	*Vertigo elatior*	(2)
Zonitoides arboreus	(15)	*Gastrocopta pentodon*	(1)
Euconulus alderi	(12)	Immature *Cochlicopa*	(3)
Punctum minutissimum	(11)	Immature Pupillidae	(3)
Nesovitrea binneyana	(9)	Immature Succineidae	(2)
Helicodiscus parallelus	(7)		

Oakland 1

Location: 95.6845 W., 47.2211 N.
Habitat Type: Oak Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 745

Mature Red Oak, Sugar Maple, Basswood, Aspen forest with moderate leaf litter.

Zonitoides arboreus	(128)	*Gastrocopta contracta*	(11)
Carychium exile	(123)	*Helicodiscus parallelus*	(9)
Strobilops labyrinthica	(94)	***Vertigo arthuri***	**(5)**
Discus catskillensis	(75)	*Columella simplex*	(4)
Striatura milium	(62)	*Discus cronkhitei*	(4)
Punctum vitreum	(60)	*Deroceras laeve*	(1)
Vallonia gracilicosta	(60)	Immature Pupillidae	(10)
Euconulus fulvus	(54)	Immature *Cochlicopa*	(3)
Nesovitrea binneyana	(23)	Immature Succineidae	(1)
Gastrocopta pentodon	(18)		

Oakland 2

Location: 95.6889 W., 47.2034 N.
Habitat Type: Tamarack Wetland
Richness: 15

Habitat Group: Lowland Forest
Total Abundance: 485

Wet Tamarack, Alder, Black Ash, Balsam swamp forest with moss and sedge groundlayer.

Strobilops labyrinthica	(102)	*Discus catskillensis*	(22)
Striatura exigua	(68)	*Gastrocopta tappaniana*	(18)
Carychium exiguum	(52)	*Euconulus alderi*	(16)
Zonitoides arboreus	(40)	*Punctum* n.sp.	(16)
Carychium exile	(33)	*Vertigo elatior*	(14)
Nesovitrea electrina	(31)	***Vertigo nylanderi***	**(7)**
Nesovitrea binneyana	(29)	*Vertigo cristata*	(2)

Carychium exiguum	(703)	*Punctum* n.sp.	(79)
Strobilops affinis	(361)	*Oxyloma retusa*	(49)
Nesovitrea electrina	(339)	*Vertigo elatior*	(37)
Gastrocopta tappaniana	(291)	*Vertigo morsei*	(20)
Discus cronkhitei	(257)	*Zonitoides arboreus*	(15)
Catinella exile	(173)	*Vallonia gracilicosta*	(12)
Hawaiia minuscula	(157)	*Carychium exile*	(1)
Vertigo milium	(109)	*Deroceras laeve*	(1)
Euconulus alderi	(93)	Immature Pupillidae	(218)

Waubun SE 2

Location: 95.9177 W., 47.1681 N.
Habitat Type: Mesic Prairie
Richness: 8

Habitat Group: Upland Grassland
Total Abundance: 220

Degraded tallgrass prairie remnant.

Vallonia pulchella	(69)	*Discus cronkhitei*	(1)
Vallonia costata	(64)	*Gastrocopta holzingeri*	(1)
Hawaiia minuscula	(8)	*Nesovitrea electrina*	(1)
Punctum minutissimum	(3)	Immature *Vallonia*	(73)

Whiskey Creek Lake

Location: 95.7846 47.2308
Habitat Type: Aspen Forest
Richness: 19

Habitat Group: Upland Forest
Total Abundance: 326

Dry Aspen, Bur Oak, Ash forest with Hazel understory; thin leaf litter over hard clay soil.

Strobilops labyrinthica	(103)	*Discus catskillensis*	(6)
Striatura milium	(61)	*Nesovitrea electrina*	(6)
Punctum minutissimum	(47)	*Gastrocopta holzingeri*	(4)
Zonitoides arboreus	(23)	*Vallonia gracilicosta*	(2)
Nesovitrea binneyana	(15)	*Vertigo arthuri*	(2)
Hawaiia minuscula	(14)	*Gastrocopta contracta*	(1)
Euconulus fulvus	(12)	*Gastrocopta tappaniana*	(1)
Carychium exile	(8)	Immature Pupillidae	(4)
Columella simplex	(8)	Immature Succineidae	(1)
Gastrocopta pentodon	(7)	Immature *Cochlicopa*	(1)

Marshall County

East Park WMA 1

Location: 96.2964 W., 48.5310 N.
Habitat Type: Aspen Forest
Richness: 11

Habitat Group: Upland Forest
Total Abundance: 255

Upland Aspen-Bur Oak forest with thin leaf litter over hard soil.

Nesovitrea binneyana	(75)	*Vertigo arthuri*	(9)
Strobilops labyrinthica	(62)	*Gastrocopta pentodon*	(8)
Striatura milium	(33)	*Cochlicopa lubricella*	(4)
Discus catskillensis	(25)	*Vitrina limpida*	(4)
Succinea ovalis	(17)	*Zonitoides arboreus*	(4)
Euconulus fulvus	(14)		

East Park WMA 2

Location: 96.2790 W., 48.5326 N.
Habitat Type: Wet Prairie
Richness: 13

Habitat Group: Lowland Grassland
Total Abundance: 736

Recently burned brush prairie with Bog Birch and Shrubby Cinquefoil.

Carychium exiguum	(502)	*Zonitoides arboreus*	(9)
Gastrocopta tappaniana	(57)	*Vertigo milium*	(5)
Oxyloma retusa	(34)	*Vertigo ovata*	(5)
Nesovitrea electrina	(24)	*Punctum minutissimum*	(4)
Vertigo elatior	(22)	*Discus cronkhitei*	(2)
Cochlicopa lubricella	(14)	*Succinea ovalis*	(1)
Vallonia gracilicosta	(12)	Immature Pupillidae	(36)
Euconulus alderi	(9)		

Florian Fen

Location: 96.5559 W., 48.4425 N.
Habitat Type: Fen
Richness: 16

Habitat Group: Lowland Grassland
Total Abundance: 3923

Low turf of mounded, rich fen mat.

Carychium exiguum	(1075)	*Oxyloma retusa*	(20)
Gastrocopta tappaniana	(404)	*Strobilops labyrinthica*	(9)

Catinella exile	(271)	*Zonitoides arboreus*	(5)
Nesovitrea electrina	(241)	*Discus catskillensis*	(2)
Punctum n.sp.	(226)	*Vallonia gracilicosta*	(2)
Discus cronkhitei	(199)	*Helicodiscus parallelus*	(1)
Vertigo milium	(169)	*Striatura milium*	(1)
Euconulus alderi	(132)	Immature Pupillidae	(1102)
Vertigo elatior	(64)		

Florian WMA

Location: 96.5497 W., 48.3994 N.
Habitat Type: Aspen Forest
Richness: 15

Habitat Group: Upland Forest
Total Abundance: 1130

Young Aspen grove with deep leaf litter.

Punctum minutissimum	(166)	*Hawaiia minuscula*	(14)
Vallonia perspectiva	(131)	*Gastrocopta pentodon*	(8)
Vallonia gracilicosta	(114)	*Nesovitrea electrina*	(8)
Nesovitrea binneyana	(87)	*Strobilops labyrinthica*	(6)
Gastrocopta holzingeri	(80)	*Succinea ovalis*	(3)
Euconulus fulvus	(55)	*Cochlicopa lubricella*	(2)
Striatura milium	(19)	*Helicodiscus parallelus*	(1)
Vitrina limpida	(16)	Immature *Vallonia*	(379)
Zonitoides arboreus	(16)	Immature Pupillidae	(25)

Karlstad South

Location: 96.4844 W., 48.5373 N.
Habitat Type: Calcareous Meadow
Richness: 13

Habitat Group: Lowland Grassland
Total Abundance: 2225

Low vegetation over exposed mineral soil of moist railroad embankment.

Vertigo elatior	(477)	*Gastrocopta holzingeri*	(18)
Vertigo milium	(402)	*Cochlicopa lubrica*	(8)
Vallonia costata	(190)	*Hawaiia minuscula*	(2)
Euconulus alderi	(111)	*Zonitoides arboreus*	(2)
Gastrocopta tappaniana	(98)	*Carychium exiguum*	(1)
Nesovitrea electrina	(81)	Immature Pupillidae	(769)
Punctum minutissimum	(50)	Immature Succineidae	(16)

Moose River

Location: 95.7302 W., 48.4765 N.
Habitat Type: Tamarack Wetland
Richness: 14

Habitat Group: Lowland Forest
Total Abundance: 267

Open Tamarack-Alder swamp forest with thick grass-sedge groundcover.

Carychium exiguum	(122)	*Discus cronkhitei*	(4)
Striatura milium	(39)	*Vertigo cristata*	(3)
Punctum minutissimum	(24)	*Euconulus alderi*	(2)
Nesovitrea electrina	(23)	*Deroceras laeve*	(1)
Gastrocopta tappaniana	(13)	*Zonitoides arboreus*	(1)
Cochlicopa lubricella	(10)	Immature Pupillidae	(8)
Vertigo elatior	(8)	Immature Succineidae	(3)
Vertigo nylanderi	(6)		

Nelson Slough

Location: 96.3388 W., 48.4717 N.
Habitat Type: Aspen Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 720

Upland Aspen forest and small wet depreseeion with thin litter over hard soil.

Punctum minutissimum	(128)	*Strobilops labyrinthica*	(12)
Carychium exile	(121)	*Vitrina limpida*	(7)
Vallonia gracilicosta	(92)	*Catinella avara*	(6)
Gastrocopta tappaniana	(82)	*Hawaiia minuscula*	(5)
Striatura milium	(62)	*Discus catskillensis*	(4)
Euconulus fulvus	(60)	*Euconulus alderi*	(3)
Nesovitrea electrina	(57)	*Vertigo elatior*	(3)
Vertigo arthuri	(24)	*Deroceras laeve*	(1)
Cochlicopa lubricella	(17)	Immature Pupillidae	(22)
Zonitoides arboreus	(14)		

Old Mill State Park

Location: 96.5657 W., 48.3666 N.
Habitat Type: Aspen Forest
Richness: 21

Habitat Group: Upland Forest
Total Abundance: 2221

Mature Aspen, Bur Oak, Back Cerry forest with deep leaf litter.

Striatura milium	(462)	*Cochlicopa lubricella*	(34)
Nesovitrea binneyana	(250)	*Succinea ovalis*	(30)
Strobilops labyrinthica	(214)	*Nesovitrea electrina*	(25)
Gastrocopta pentodon	(166)	***Vertigo arthuri***	**(22)**
Discus catskillensis	(124)	*Gastrocopta holzingeri*	(17)
Vallonia gracilicosta	(99)	*Helicodiscus parallelus*	(12)
Zonitoides arboreus	(88)	*Vitrina limpida*	(9)
Euconulus fulvus	(87)	*Discus cronkhitei*	(4)
Punctum minutissimum	(68)	*Carychium exile*	(2)
Hawaiia minuscula	(43)	Immature *Vallonia*	(237)
Vallonia perspectiva	(42)	Immature Pupillidae	(146)
Gastrocopta contracta	(40)		

Radium NE 1

Location: 96.5439 W., 48.2802 N.
Habitat Type: Mesic Prairie
Richness: 11

Habitat Group: Upland Grassland
Total Abundance: 493

Dry-mesic prairie remant with thick thatch and leaf litter accumulations under small shrubs.

Vallonia gracilicosta	(237)	*Catinella avara*	(5)
Punctum minutissimum	(87)	*Carychium exiguum*	(4)
Gastrocopta holzingeri	(54)	*Gastrocopta tappaniana*	(2)
Nesovitrea electrina	(27)	*Hawaiia minuscula*	(1)
Euconulus fulvus	(24)	*Vertigo ovata*	(1)
Vertigo milium	(19)	Immature Pupillidae	(32)

Radium NE 2

Location: 96.5444 W., 48.2796 N.
Habitat Type: Aspen Forest
Richness: 13

Habitat Group: Upland Forest
Total Abundance: 508

Wet-mesic Aspen forest with dense Poison Ivy groundlayer.

Carychium exiguum	(203)	*Cochlicopa lubricella*	(11)
Gastrocopta tappaniana	(50)	*Euconulus fulvus*	(9)
Nesovitrea electrina	(47)	*Zonitoides arboreus*	(5)
Striatura milium	(46)	*Discus catskillensis*	(3)
Vallonia gracilicosta	(39)	*Gastrocopta holzingeri*	(3)
Catinella avara	(30)	*Hawaiia minuscula*	(2)
Punctum minutissimum	(15)	Immature Pupillidae	(45)

Randeen Ridge

Location: 95.6474 W., 48.4791 N.
Habitat Type: Black Ash Wetland
Richness: 19

Habitat Group: Lowland Forest
Total Abundance: 1920

Wet-mesic Black Ash, Balsam Poplar, Mountain Maple forest with deep leaf litter.

Carychium exile	(388)	*Gastrocopta tappaniana*	(39)
Punctum minutissimum	(285)	***Vertigo arthuri***	**(34)**
Discus catskillensis	(226)	*Vitrina limpida*	(33)
Vallonia gracilicosta	(197)	*Zonitoides arboreus*	(32)
Striatura milium	(160)	*Carychium exiguum*	(14)
Nesovitrea binneyana	(120)	*Columella simplex*	(12)
Cochlicopa lubricella	(119)	*Hawaiia minuscula*	(10)
Strobilops labyrinthica	(103)	*Succinea ovalis*	(10)
Euconulus fulvus	(50)	*Vertigo elatior*	(2)
Nesovitrea electrina	(50)	Immature Pupillidae	(36)

Strathcona SW

Location: 96.2329 W., 48.5300 N.
Habitat Type: Black Ash Wetland
Richness: 25

Habitat Group: Lowland Forest
Total Abundance: 5492

Rich Black Ash, White Spruce, Tamarack swamp forest with deep leaf litter.

Vallonia gracilicosta	(1380)	*Nesovitrea binneyana*	(73)
Carychium exile	(1122)	*Gastrocopta pentodon*	(64)
Punctum minutissimum	(691)	*Euconulus alderi*	(59)
Strobilops labyrinthica	(493)	***Vertigo arthuri***	**(25)**
Nesovitrea electrina	(360)	*Euconulus fulvus*	(16)
Carychium exiguum	(231)	*Columella simplex*	(14)
Cochlicopa lubricella	(221)	*Discus catskillensis*	(12)
Striatura milium	(198)	*Gastrocopta holzingeri*	(10)
Succinea ovalis	(150)	*Vertigo elatior*	(9)
Discus cronkhitei	(124)	***Vertigo nylanderi***	**(7)**
Zonitoides arboreus	(89)	*Vitrina limpida*	(2)
Gastrocopta tappaniana	(84)	*Punctum* n.sp.	(1)
Hawaiia minuscula	(74)	Immature Pupillidae	(91)

Thief Lake WMA 1

Location: 96.0206 W., 48.5299 N.
Habitat Type: Oak Forest
Richness: 11

Habitat Group: Upland Forest
Total Abundance: 601

Mature Bur Oak forest with Viburnum understory with thick leaf litter.

Strobilops labyrinthica	(192)	*Zonitoides arboreus*	(31)
Punctum minutissimum	(85)	*Euconulus fulvus*	(22)
Nesovitrea binneyana	(84)	*Gastrocopta pentodon*	(5)
Striatura milium	(75)	*Succinea ovalis*	(2)
Vallonia gracilicosta	(62)	Immature *Cochlicopa*	(1)
Discus catskillensis	(42)		

Thief Lake WMA 2

Location: 96.0230 W., 48.5429 N.
Habitat Type: Tamarack Wetland
Richness: 20

Habitat Group: Lowland Forest
Total Abundance: 734

Rich Tamarack-Black Ash swamp forest

Carychium exiguum	(134)	***Vertigo nylanderi***	**(19)**
Discus catskillensis	(121)	*Cochlicopa lubricella*	(18)
Carychium exile	(92)	*Nesovitrea binneyana*	(18)
Striatura milium	(65)	*Discus cronkhitei*	(8)
Punctum minutissimum	(58)	*Succinea ovalis*	(2)
Nesovitrea electrina	(46)	*Anguispira alternata*	(1)
Gastrocopta tappaniana	(28)	***Vertigo arthuri***	**(1)**
Striatura exigua	(26)	*Vertigo cristata*	(1)
Euconulus alderi	(24)	*Zonitoides arboreus*	(1)
Vertigo elatior	(24)	Immature Pupillidae	(25)
Strobilops labyrinthica	(22)		

Thief Lake WMA 3

Location: 96.0220 W., 48.5427 N.
Habitat Type: Sedge Meadow
Richness: 15

Habitat Group: Lowland Grassland
Total Abundance: 1830

Wet sedge meadow.

Strobilops labyrinthica	(593)	*Zonitoides arboreus*	(48)

Carychium exiguum	(324)	*Euconulus alderi*	(44)
Striatura milium	(300)	*Vertigo elatior*	(33)
Nesovitrea electrina	(96)	*Carychium exile*	(32)
Cochlicopa lubricella	(89)	*Succinea ovalis*	(20)
Gastrocopta tappaniana	(76)	*Discus cronkhitei*	(4)
Punctum n.sp.	(73)	*Striatura exigua*	(3)
Discus catskillensis	(52)	Immature Pupillidae	(70)

Norman County

Faith South 1

Location: 96.0866 W., 47.2617 N.
Habitat Type: Fen
Richness: 15

Habitat Group: Lowland Grassland
Total Abundance: 3048

Low vegetation on sedge mat of calcareous fen.

Carychium exiguum	(799)	*Strobilops labyrinthica*	(80)
Gastrocopta tappaniana	(383)	*Vertigo elatior*	(45)
Catinella exile	(273)	*Deroceras laeve*	(12)
Nesovitrea electrina	(249)	*Vertigo morsei*	(5)
Hawaiia minuscula	(207)	*Oxyloma retusa*	(4)
Euconulus alderi	(196)	*Zonitoides arboreus*	(4)
Punctum n.sp.	(155)	*Punctum minutissimum*	(1)
Discus cronkhitei	(127)	Immature Pupillidae	(405)
Vertigo milium	(103)		

Faith South 2

Location: 96.0823 W., 47.2612 N.
Habitat Type: Aspen Forest
Richness: 20

Habitat Group: Upland Forest
Total Abundance: 1459

Wet-mesic Aspen grove with deep leaf litter.

Vallonia gracilicosta	(358)	*Euconulus fulvus*	(30)
Strobilops labyrinthica	(239)	*Hawaiia minuscula*	(26)
Punctum minutissimum	(151)	*Deroceras laeve*	(16)
Gastrocopta holzingeri	(118)	*Discus cronkhitei*	(11)
Nesovitrea electrina	(107)	*Catinella avara*	(8)
Carychium exile	(104)	*Helicodiscus parallelus*	(8)
Zonitoides arboreus	(59)	*Cochlicopa lubricella*	(4)
Carychium exiguum	(52)	*Vertigo milium*	(4)

Gastrocopta tappaniana	(50)	*Vitrina limpida*	(4)
Gastrocopta contracta	(44)	Immature Pupillidae	(61)
Nesovitrea binneyana	(41)		

Prairie Smoke Dunes 1

Location: 96.3062 W., 47.4622 N.
Habitat Type: Sand Prairie
Richness: 3

Habitat Group: Upland Grassland
Total Abundance: 19

Leaf litter accumulations under small shrubs on xeric sand dune grassland.

Gastrocopta holzingeri	(16)	*Carychium exiguum*	(1)
Vallonia perspectiva	(2)		

Prairie Smoke Dunes 2

Location: 96.3036 W., 47.4620 N.
Habitat Type: Maple-Basswood Forest
Richness: 22

Habitat Group: Upland Forest
Total Abundance: 2754

Rich, mesic Basswood-Aspen woods on north-facing slope of dunes with deep leaf litter.

Punctum minutissimum	(757)	*Striatura milium*	(20)
Gastrocopta holzingeri	(612)	***Vertigo arthuri***	(17)
Vallonia gracilicosta	(116)	*Discus catskillensis*	(11)
Vallonia perspectiva	(114)	*Gastrocopta tappaniana*	(11)
Nesovitrea binneyana	(94)	*Nesovitrea electrina*	(9)
Cochlicopa lubricella	(59)	*Catinella avara*	(6)
Euconulus fulvus	(51)	*Hawaiia minuscula*	(3)
Carychium exile	(41)	*Strobilops labyrinthica*	(3)
Zonitoides arboreus	(30)	*Columella simplex*	(1)
Carychium exiguum	(27)	*Deroceras laeve*	(1)
Gastrocopta pentodon	(26)	Immature *Vallonia*	(494)
Gastrocopta contracta	(22)	Immature Pupillidae	(229)

Sandpiper Prairie

Location: 96.4060 W., 47.2454 N.
Habitat Type: Wet Prairie
Richness: 11

Habitat Group: Lowland Prairie
Total Abundance: 1261

Leaf litter accumulations under Dogwood-Current shrubs on Cordgrass-dominated wet prairie.

Vallonia pulchella	(702)	*Euconulus alderi*	(24)
Vertigo ovata	(112)	*Hawaiia minuscula*	(21)
Oxyloma retusa	(102)	*Catinella avara*	(5)
Gastrocopta tappaniana	(54)	*Deroceras laeve*	(1)
Vertigo milium	(33)	*Discus cronkhitei*	(1)
Zonitoides arboreus	(26)	Immature Pupillidae	(180)

Twin River Park

Location: 96.2747 W., 47.2851 N.
Habitat Type: Oak Forest
Richness: 16

Habitat Group: Upland Forest
Total Abundance: 278

Bur Oak woods with thin litter over hard soil on south-facing hillside.

Vallonia costata	(57)	*Euconulus fulvus*	(3)
Vallonia pulchella	(26)	*Gastrocopta pentodon*	(3)
Gastrocopta holzingeri	(15)	*Hawaiia minuscula*	(2)
Strobilops labyrinthica	(13)	*Striatura milium*	(2)
Succinea ovalis	(10)	*Anguispira alternata*	(1)
Zonitoides arboreus	(8)	*Cochlicopa lubricella*	(1)
Gastrocopta contracta	(6)	*Nesovitrea binneyana*	(1)
Cochlicopa lubrica	(4)	Immature *Vallonia*	(114)
Helicodiscus parallelus	(4)	Immature Pupillidae	(8)

Pennington County

Goose Lake 1

Location: 96.4625 W., 48.0947 N.
Habitat Type: Aspen Forest
Richness: 11

Habitat Group: Upland Forest
Total Abundance: 755

Mesic-wet Aspen-Willow forest with moderate leaf litter

Punctum minutissimum	(229)	*Cochlicopa lubricella*	(37)
Nesovitrea electrina	(126)	*Zonitoides arboreus*	(10)
Vallonia gracilicosta	(107)	*Discus catskillensis*	(6)
Vertigo arthuri	(57)	*Gastrocopta tappaniana*	(1)
Gastrocopta contracta	(49)	Immature Pupillidae	(77)
Euconulus alderi	(48)	Immature Succineidae	(8)

Goose Lake 2

Location: 96.4622 W., 48.0937 N.
Habitat Type: Wet Prairie
Richness: 16

Habitat Group: Lowland Grassland
Total Abundance: 996

Thatch and litter accumulations under Shrubby Cinquefoil and Bog Birch on brush prairie.

Punctum minutissimum	(210)	*Catinella avara*	(20)
Vallonia gracilicosta	(152)	*Gastrocopta contracta*	(4)
Gastrocopta tappaniana	(117)	*Discus cronkhitei*	(3)
Nesovitrea electrina	(91)	*Zonitoides arboreus*	(3)
Gastrocopta holzingeri	(66)	*Cochlicopa lubricella*	(1)
Vertigo milium	(63)	*Deroceras laeve*	(1)
Euconulus alderi	(58)	*Discus catskillensis*	(1)
Hawaiia minuscula	(35)	Immature Pupillidae	(145)
Cochlicopa lubrica	(26)		

Higenbotham WMA 1

Location: 96.3035 48.0069
Habitat Type: Aspen Forest
Richness: 20

Habitat Group: Upland Forest
Total Abundance: 1164

Mature Aspen-Bur Oak forest with moderate leaf litter.

Striatura milium	(172)	*Zonitoides arboreus*	(23)
Carychium exile	(165)	*Nesovitrea electrina*	(22)
Gastrocopta pentodon	(85)	*Euconulus fulvus*	(18)
Nesovitrea binneyana	(84)	*Discus catskillensis*	(17)
Vertigo arthuri	**(78)**	*Gastrocopta holzingeri*	(14)
Vallonia gracilicosta	(76)	*Hawaiia minuscula*	(11)
Gastrocopta tappaniana	(73)	*Columella simplex*	(1)
Punctum minutissimum	(70)	*Discus cronkhitei*	(1)
Euconulus alderi	(68)	Immature Pupillidae	(102)
Strobilops labyrinthica	(45)	Immature *Cochlicopa*	(5)
Vitrina limpida	(34)		

Higenbotham WMA 2

Location: 96.2946 W., 48.0061 N.
Habitat Type: Wet Prairie
Richness: 22

Habitat Group: Lowland Grassland
Total Abundance: 1114

Willow and Aspen scrub along margin of wet Brush Prairie.

Punctum minutissimum	(252)	*Vertigo elatior*	(17)
Carychium exiguum	(214)	*Gastrocopta contracta*	(15)
Nesovitrea electrina	(108)	*Strobilops labyrinthica*	(13)
Gastrocopta tappaniana	(106)	*Vertigo milium*	(13)
Vallonia gracilicosta	(98)	*Zonitoides arboreus*	(10)
Euconulus alderi	(57)	*Vertigo ovata*	(6)
Carychium exile	(51)	*Gastrocopta holzingeri*	(4)
Discus cronkhitei	(42)	*Hawaiia minuscula*	(4)
Catinella avara	(36)	*Oxyloma retusa*	(4)
Vertigo arthuri	(31)	*Striatura milium*	(3)
Cochlicopa lubricella	(27)	*Vitrina limpida*	(3)

Oak Ridge

Location: 96.3555 48.1487
Habitat Type: Oak Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 1830

Mature Bur Oak-Aspen forest with deep leaf litter on west-facing ridge.

Carychium exile	(208)	*Gastrocopta holzingeri*	(72)
Vallonia gracilicosta	(208)	*Zonitoides arboreus*	(64)
Gastrocopta pentodon	(185)	*Gastrocopta contracta*	(16)
Nesovitrea binneyana	(174)	*Cochlicopa lubricella*	(12)
Discus catskillensis	(155)	*Columella simplex*	(8)
Strobilops labyrinthica	(149)	*Vitrina limpida*	(5)
Striatura milium	(143)	*Hawaiia minuscula*	(1)
Punctum minutissimum	(105)	Immature Pupillidae	(169)
Vertigo arthuri	(79)	Immature Succineidae	(1)
Euconulus fulvus	(76)		

River Valley East

Location: 95.6862 W., 48.0191 N.
Habitat Type: Aspen Forest
Richness: 15

Habitat Group: Upland Forest
Total Abundance: 216

Mature Aspen, Bur Oak, Black Cherry forest with thin leaf litter over hard clay soil.

Cochlicopa lubrica	(83)	*Zonitoides arboreus*	(7)
Strobilops labyrinthica	(46)	*Cochlicopa lubricella*	(5)
Nesovitrea electrina	(20)	*Succinea ovalis*	(3)

Vitrina limpida	(13)	*Columella simplex*	(1)
Striatura milium	(11)	*Vallonia gracilicosta*	(1)
Carychium exile	(7)	***Vertigo arthuri***	**(1)**
Euconulus fulvus	(7)	Immature Pupillidae	(3)
Nesovitrea binneyana	(7)	Immature *Discus*	(1)

Sanders Fen

Location: 96.3524 W., 48.0645 N.
Habitat Type: Fen
Richness: 14

Habitat Group: Lowland Grassland
Total Abundance: 2219

Leaf litter under Shrubby Cinquefoil and thatch of sedge mat on calcareous fen.

Carychium exiguum	(480)	*Hawaiia minuscula*	(39)
Punctum n.sp.	(360)	*Strobilops labyrinthica*	(39)
Gastrocopta tappaniana	(249)	*Discus cronkhitei*	(14)
Euconulus alderi	(137)	***Vertigo morsei***	**(8)**
Nesovitrea electrina	(137)	*Zonitoides arboreus*	(5)
Catinella exile	**(85)**	*Vallonia pulchella*	(3)
Vertigo milium	(81)	*Punctum minutissimum*	(1)
Vertigo elatior	(62)	Immature Pupillidae	(519)

Smiley WMA

Location: 96.0663 W., 48.0467 N.
Habitat Type: Aspen Forest
Richness: 10

Habitat Group: Upland Forest
Total Abundance: 197

Lowland Aspen-Willow grove with moderate leaf litter.

Vallonia pulchella	(105)	*Euconulus fulvus*	(6)
Discus cronkhitei	(37)	*Vitrina limpida*	(3)
Nesovitrea electrina	(24)	*Euconulus alderi*	(1)
Cochlicopa lubrica	(9)	*Striatura milium*	(1)
Zonitoides arboreus	(8)	Immature Succineidae	(3)

Polk County

Chicog Prairie

Location: 96.3872 W., 47.5980 N.
Habitat Type: Xeric Prairie
Richness: 2

Habitat Group: Upland Grassland
Total Abundance: 153

Heavily burned xeric gravel prairie

Gastrocopta holzingeri	(131)	*Vallonia parvula*	(22)

Dugdale WMA

Location: 96.2787 W., 47.6848 N.
Habitat Type: Aspen Forest
Richness: 14

Habitat Group: Upland Forest
Total Abundance: 258

Mesic Aspen-Balsam Poplar grove with moderate leaf litter.

Punctum minutissimum	(41)	*Zonitoides arboreus*	(11)
Carychium exiguum	(40)	*Euconulus fulvus*	(9)
Vallonia gracilicosta	(39)	*Deroceras laeve*	(8)
Vertigo arthuri	**(28)**	*Gastrocopta tappaniana*	(6)
Nesovitrea electrina	(23)	*Vertigo milium*	(4)
Gastrocopta holzingeri	(19)	*Catinella avara*	(3)
Hawaiia minuscula	(15)	Immature *Cochlicopa*	(12)

Erskine North

Location: 96.0009 W., 47.7381 N.
Habitat Type: Wet Prairie
Richness: 18

Habitat Group: Lowland Grassland
Total Abundance: 741

Rich, calcareous, low prairie along railroad.

Oxyloma retusa	(141)	*Deroceras laeve*	(4)
Vertigo milium	(140)	*Gastrocopta contracta*	(3)
Vertigo elatior	(94)	*Vallonia costata*	(3)
Vallonia pulchella	(59)	*Catinella avara*	(2)
Gastrocopta tappaniana	(54)	*Discus cronkhitei*	(1)
Nesovitrea electrina	(37)	*Gastrocopta holzingeri*	(1)
Euconulus alderi	(36)	*Punctum minutissimum*	(1)
Hawaiia minuscula	(36)	*Zonitoides nitidus*	(1)
Carychium exiguum	(20)	Immature Pupillidae	(89)
Vertigo ovata	(19)		

Gulley Fen 1

Location: 95.6227 W., 47.8037 N.
Habitat Type: Fen
Richness: 14

Habitat Group: Lowland Grassland
Total Abundance: 2032

Moss, thatch and leaf litter from Bog Birch-Shrubby Cinquefoil clumps on sedge mat of fen.

Carychium exiguum	(565)	*Catinella exile*	(19)
Gastrocopta tappaniana	(309)	*Discus catskillensis*	(17)
Nesovitrea electrina	(257)	***Vertigo morsei***	**(7)**
Vertigo elatior	(173)	*Gastrocopta contracta*	(5)
Euconulus alderi	(105)	***Vertigo arthuri***	**(2)**
Strobilops affinis	(102)	***Vertigo nylanderi***	**(2)**
Punctum minutissimum	(88)	*Vitrina limpida*	(1)
Punctum n.sp.	(59)	*Zonitoides arboreus*	(1)
Vertigo milium	(41)	Immature Pupillidae	(243)
Oxyloma retusa	(36)		

Gulley Fen 2

Location: 95.6218 W., 47.8032 N.
Habitat Type: Tamarack Wetland
Richness: 16

Habitat Group: Lowland Forest
Total Abundance: 787

Tamarack swamp forest island in fen with dense moss-sedge groundcover.

Carychium exiguum	(234)	*Punctum* n.sp.	(7)
Nesovitrea electrina	(95)	*Vallonia gracilicosta*	(7)
Strobilops labyrinthica	(82)	*Strobilops affinis*	(6)
Gastrocopta tappaniana	(67)	*Gastrocopta contracta*	(3)
Punctum minutissimum	(51)	***Vertigo nylanderi***	**(3)**
Vertigo arthuri	**(47)**	*Hawaiia minuscula*	(2)
Vertigo elatior	(39)	*Columella simplex*	(1)
Euconulus alderi	(31)	Immature Pupillidae	(75)
Zonitoides arboreus	(20)	Immature Succineidae	(3)
Discus cronkhitei	(14)		

Gully North

Location: 95.6250 W., 47.8944 N.
Habitat Type: Aspen Forest
Richness: 15

Habitat Group: Upland Forest
Total Abundance: 2249

Aspen and Balsam Poplar forest disturbed through fire and tree cutting.

Vallonia gracilicosta	(767)	*Gastrocopta tappaniana*	(44)
Carychium exile	(373)	*Gastrocopta pentodon*	(37)
Nesovitrea binneyana	(322)	*Zonitoides arboreus*	(35)
Punctum minutissimum	(223)	*Euconulus fulvus*	(23)
Nesovitrea electrina	(102)	*Hawaiia minuscula*	(22)
Cochlicopa lubricella	(91)	*Vitrina limpida*	(7)
Striatura milium	(72)	*Discus cronkhitei*	(2)
Discus catskillensis	(65)	Immature Pupillidae	(64)

Hagen WPA

Location: 95.5985 47.5875
Habitat Type: Maple-Basswood Forest
Richness: 16

Habitat Group: Upland Forest
Total Abundance: 379

Mature Sugar Maple, Basswood, Balsam forest with thin leaf litter over hard clay soil.

Zonitoides arboreus	(94)	*Nesovitrea binneyana*	(5)
Discus catskillensis	(60)	*Striatura exigua*	(4)
Carychium exile	(54)	*Vallonia gracilicosta*	(4)
Euconulus fulvus	(42)	*Helicodiscus parallelus*	(3)
Strobilops labyrinthica	(41)	*Anguispira alternata*	(2)
Nesovitrea electrina	(22)	*Discus cronkhitei*	(2)
Striatura milium	(16)	*Gastrocopta pentodon*	(2)
Gastrocopta contracta	(14)	Immature Pupillidae	(6)
Punctum minutissimum	(8)		

Malmberg Prairie

Location: 96.8235 47.7311
Habitat Type: Wet Prairie
Richness: 6

Habitat Group: Lowland Grassland
Total Abundance: 563

Wet-mesic prairie in Red River floodplain.

Vallonia pulchella	(84)	*Vallonia gracilicosta*	(26)
Vallonia perspectiva	(71)	*Gastrocopta abbreviata*	(1)
Vertigo ovata	(54)	Immature *Vallonia*	(296)
Catinella avara	(31)		

Maple Lake

Location: 96.1289 W., 47.6588 N.
Habitat Type: Maple-Basswood Forest
Richness: 14

Habitat Group: Upland Forest
Total Abundance: 182

Upland Sugar Maple-Basswood forest with dense sedge groundcover but thin litter layer over hard clay soil.

Nesovitrea binneyana	(51)	*Discus catskillensis*	(5)
Strobilops labyrinthica	(38)	*Carychium exile*	(3)
Cochlicopa lubricella	(26)	*Columella simplex*	(2)
Euconulus fulvus	(13)	*Helicodiscus parallelus*	(1)
Striatura milium	(11)	*Vitrina limpida*	(1)
Zonitoides arboreus	(10)	Immature Pupillidae	(12)
Punctum minutissimum	(9)		

Maple Lake Church WPA 1

Location: 96.1725 W., 47.6138 N.
Habitat Type: Aspen Forest
Richness: 18

Habitat Group: Upland Forest
Total Abundance: 1106

Mature Aspen, Bur Oak, Paper Birch forest on island in marsh with deep leaf litter.

Carychium exile	(188)	*Punctum minutissimum*	(23)
Nesovitrea binneyana	(180)	*Euconulus fulvus*	(17)
Vallonia gracilicosta	(110)	*Vertigo arthuri*	(17)
Striatura milium	(94)	*Helicodiscus parallelus*	(16)
Gastrocopta pentodon	(87)	*Discus catskillensis*	(14)
Strobilops labyrinthica	(86)	*Hawaiia minuscula*	(14)
Vitrina limpida	(75)	*Columella simplex*	(10)
Gastrocopta contracta	(53)	*Gastrocopta holzingeri*	(9)
Cochlicopa lubricella	(36)	Immature Pupillidae	(42)
Zonitoides arboreus	(35)		

Maple Lake Church WPA 2

Location: 96.1715 W., 47.6142 N.
Habitat Type: Shrub Carr
Richness: 16

Habitat Group: Lowland Forest
Total Abundance: 1558

Wet leaf litter and thatch under Willow, Dogwood, Bog Birch shrub carr.

Carychium exiguum	(424)	*Gastrocopta contracta*	(24)
Strobilops labyrinthica	(283)	*Discus cronkhitei*	(16)
Gastrocopta tappaniana	(192)	*Cochlicopa lubricella*	(10)
Vertigo elatior	(111)	*Zonitoides arboreus*	(8)
Nesovitrea electrina	(102)	*Deroceras laeve*	(4)
Euconulus alderi	(80)	*Hawaiia minuscula*	(2)
Punctum minutissimum	(66)	*Vallonia pulchella*	(1)
Carychium exile	(41)	Immature Pupillidae	(162)
Oxyloma retusa	(32)		

Pankratz Prairie 1

Location: 96.4436 W., 47.7230 N.
Habitat Type: Fen
Richness: 11

Habitat Group: Lowland Grassland
Total Abundance: 314

Heavily burned fen with no remaining thatch or bryophyes.

Carychium exiguum	(104)	*Gastrocopta tappaniana*	(8)
Hawaiia minuscula	(63)	*Euconulus alderi*	(6)
Vertigo milium	(41)	*Zonitoides arboreus*	(2)
Oxyloma retusa	(38)	*Catinella avara*	(1)
Nesovitrea electrina	(17)	*Discus cronkhitei*	(1)
Deroceras laeve	(8)	Immature Pupillidae	(25)

Pankratz Prairie 2

Location: 96.4419 W., 47.7231 N.
Habitat Type: Mesic Prairie
Richness: 11

Habitat Group: Upland Grassland
Total Abundance: 159

Mesic tallgrass prairie.

Punctum minutissimum	(49)	*Vertigo milium*	(7)
Hawaiia minuscula	(37)	*Discus cronkhitei*	(5)
Gastrocopta tappaniana	(21)	*Euconulus alderi*	(3)
Catinella avara	(18)	*Vallonia perspectiva*	(2)
Zonitoides arboreus	(9)	*Nesovitrea electrina*	(1)
Vallonia pulchella	(7)		

Pankratz Prairie 3

Location: 96.4468 W., 47.7192 N.
Habitat Type: Wet Prairie
Richness: 7

Habitat Group: Lowland Grassland
Total Abundance: 190

Calcareous wet prairie with *Juncus balticus, Triglochin maritima.*

Vertigo milium	(157)	***Vertigo morsei***	(4)
Vallonia pulchella	(11)	*Deroceras laeve*	(1)
Nesovitrea electrina	(10)	Immature Succineidae	(1)
Gastrocopta tappaniana	(6)		

Pembina Trail

Location: 96.3429 W., 47.7026 N.
Habitat Type: Ash Forest
Richness: 8

Habitat Group: Lowland Forest
Total Abundance: 714

Anthropogenic Willow-Ash windbreak on south side of prairie.

Vallonia gracilicosta	(545)	*Cochlicopa lubricella*	(14)
Gastrocopta similis	(74)	*Gastrocopta tappaniana*	(6)
Zonitoides arboreus	(45)	*Punctum minutissimum*	(6)
Vallonia costata	(23)	*Catinella avara*	(1)

Sand Hill Lake

Location: 95.7511 W., 47.5055 N.
Habitat Type: Lakeshore
Richness: 17

Habitat Group: Upland Forest
Total Abundance: Field Sieve

Shoreline shrub thicket.

Carychium exiguum
Columella simplex
Deroceras laeve
Discus cronkhitei
Euconulus fulvus
Gastrocopta contracta
Gastrocopta holzingeri
Gastrocopta tappaniana
Hawaiia minuscula
Nesovitrea electrina
Punctum minutissimum
Vallonia costata
Vallonia gracilicosta
Vallonia pulchella
Vertigo arthuri
Zonitoides arboreus
Zonitoides nitidus

Sather Farm

Location: 95.5806 47.5628
Habitat Type: Tamarack Wetland
Richness: 11

Habitat Group: Lowland Forest
Total Abundance: 53

Wet Tamarack-Alder margin of acid bog.

Striatura exigua	(11)	*Vertigo cristata*	(2)
Zonitoides arboreus	(11)	*Discus catskillensis*	(1)
Striatura milium	(7)	*Vertigo ovata*	(1)
Vertigo elatior	(6)	*Zonitoides nitidus*	(1)
Euconulus alderi	(4)	Immature Pupillidae	(6)
Nesovitrea electrina	(2)	Immature Succineidae	(1)

Spring Lake

Location: 95.6449 W., 47.5079 N.
Habitat Type: Sedge Meadow
Richness: 12
Habitat Group: Lowland Grassland
Total Abundance: 1781

Sedge, Cattail, Joe-Pye Weed dominated hillside seep.

Carychium exiguum	(468)	*Vertigo ovata*	(60)
Vallonia pulchella	(244)	*Punctum* n.sp.	(7)
Oxyloma retusa	(176)	*Catinella avara*	(3)
Nesovitrea electrina	(156)	*Vertigo milium*	(3)
Gastrocopta tappaniana	(151)	*Discus cronkhitei*	(2)
Vertigo elatior	(101)	Immature Pupilllidae	(333)
Euconulus alderi	(77)		

Tilberg County Park 1

Location: 95.6389 W., 47.6281 N.
Habitat Type: Oak Forest
Richness: 16
Habitat Group: Upland Forest
Total Abundance: 483

Mature Sugar Maple-Basswood forest with thin leaf litter over hard clay soil.

Cochlicopa lubrica	(253)	*Gastrocopta holzingeri*	(9)
Discus catskillensis	(49)	*Punctum minutissimum*	(7)
Carychium exile	(41)	*Cochlicopa lubricella*	(2)
Helicodiscus parallelus	(38)	*Euconulus fulvus*	(2)
Zonitoides arboreus	(31)	*Hawaiia minuscula*	(2)
Strobilops labyrinthica	(22)	*Nesovitrea binneyana*	(1)
Striatura milium	(13)	*Nesovitrea electrina*	(1)
Gastrocopta contracta	(11)	Immature *Vallonia*	(1)

Tilberg County Park 2

Location: 95.6372 W., 47.6275 N.
Habitat Type: Lakeshore
Richness: 17

Habitat Group: Upland Forest
Total Abundance: Field Sieve

Anguispira alternata
Carychium exile
Columella simplex
Euconulus fulvus
Gastrocopta holzingeri
Gastrocopta pentodon
Hawaiia minuscula
Helicodiscus parallelus
Punctum minutissimum
Striatura milium
Strobilops labyrinthica
Vallonia costata
Vallonia gracilicosta
Vallonia perspectiva
Vallonia pulchella
Vitrina limpida
Zonitoides arboreus

Turtle Lake

Location: 95.6620 W., 47.6046 N.
Habitat Type: Lakeshore
Richness: 18

Habitat Group: Upland Forest
Total Abundance: Field Sieve

Deep leaf litter on wooded, sandy lakeshore

Carychium exile
Cochlicopa lubricella
Deroceras laeve
Discus catskillensis
Euconulus fulvus
Gastrocopta contracta
Gastrocopta holzingeri
Gastrocopta pentodon
Hawaiia minuscula
Nesovitrea binneyana
Nesovitrea electrina
Punctum minutissimum
Striatura milium
Strobilops labyrinthica
Vallonia costata
Vallonia gracilicosta
Vertigo arthuri
Zonitoides arboreus

Red Lake County

Crane WMA 1

Location: 95.7137 W., 47.8909 N.
Habitat Type: Wet Prairie
Richness: 14

Habitat Group: Lowland Grassland
Total Abundance: 425

Short vegetation on calcareous low prairie.

Gastrocopta tappaniana	(241)	*Nesovitrea binneyana*	(5)
Vertigo elatior	(41)	*Vertigo ovata*	(5)
Catinella avara	(30)	*Hawaiia minuscula*	(3)
Euconulus alderi	(27)	*Cochlicopa lubricella*	(1)
Nesovitrea electrina	(15)	*Deroceras laeve*	(1)
Zonitoides arboreus	(11)	Immature Pupillidae	(29)
Discus cronkhitei	(9)	Immature *Vallonia*	(1)
Punctum n.sp.	(6)		

Crane WMA 2

Location: 95.7113 W., 47.8904 N.
Habitat Type: Aspen Forest
Richness: 11

Habitat Group: Upland Forest
Total Abundance: 209

Wet-mesic aspen grove with thin leaf litter layer.

Carychium exiguum	(81)	*Vertigo elatior*	(6)
Nesovitrea electrina	(46)	*Vallonia gracilicosta*	(4)
Cochlicopa lubricella	(28)	***Vertigo arthuri***	**(3)**
Gastrocopta tappaniana	(17)	*Discus catskillensis*	(2)
Punctum minutissimum	(10)	*Zonitoides arboreus*	(2)
Euconulus fulvus	(8)	Immature Succineidae	(2)

Cyr Creek

Location: 96.2700 W., 47.8028 N.
Habitat Type: Wet Prairie
Richness: 20

Habitat Group: Lowland Grassland
Total Abundance: 1845

Wet-mesic prairie with Willow, Bog Birch, and Aspen clumps.

Punctum minutissimum	(537)	*Vallonia gracilicosta*	(13)
Vallonia pulchella	(96)	*Discus cronkhitei*	(11)
Carychium exiguum	(88)	*Euconulus fulvus*	(11)
Vallonia costata	(86)	*Oxyloma retusa*	(8)
Nesovitrea electrina	(76)	*Gastrocopta similis*	(6)
Vertigo milium	(64)	*Zonitoides arboreus*	(4)
Gastrocopta tappaniana	(56)	***Vertigo arthuri***	**(3)**
Euconulus alderi	(47)	*Deroceras laeve*	(1)
Hawaiia minuscula	(42)	*Gastrocopta holzingeri*	(1)
Vertigo elatior	(41)	Immature *Vallonia*	(496)
Catinella avara	(38)	Immature Pupillidae	(120)

Emardville Aspen

Location: 96.0549 W., 47.8596 N.
Habitat Type: Aspen Forest
Richness: 21

Habitat Group: upland Forest
Total Abundance: 1431

Mesic Aspen, Bur Oak, Balsam Poplar forest with deep leaf litter layer.

Nesovitrea binneyana	(268)	*Gastrocopta holzingeri*	(26)
Strobilops labyrinthica	(261)	***Vertigo arthuri***	**(26)**
Carychium exile	(126)	*Gastrocopta tappaniana*	(18)
Punctum minutissimum	(122)	*Nesovitrea electrina*	(16)
Striatura milium	(113)	*Succinea ovalis*	(13)
Gastrocopta pentodon	(98)	*Zonitoides arboreus*	(12)
Carychium exiguum	(56)	*Columella simplex*	(10)
Euconulus fulvus	(54)	*Gastrocopta contracta*	(7)
Vallonia gracilicosta	(38)	*Vertigo milium*	(3)
Cochlicopa lubricella	(36)	*Hawaiia minuscula*	(1)
Discus catskillensis	(33)	Immature Pupillidae	(94)

Huot Forest WMA

Location: 96.4219 W., 47.8742 N.
Habitat Type: Aspen Forest
Richness: 21

Habitat Group: Upland Forest
Total Abundance: 1642

Upland Aspen-Bur Oak forest with Prickly Ash understory and a thick leaf litter layer.

Striatura milium	(232)	*Vitrina limpida*	(42)
Carychium exile	(212)	***Vertigo arthuri***	**(26)**
Punctum minutissimum	(165)	*Hawaiia minuscula*	(19)
Strobilops labyrinthica	(149)	*Zonitoides arboreus*	(12)
Nesovitrea binneyana	(131)	*Gastrocopta contracta*	(11)
Gastrocopta pentodon	(100)	*Helicodiscus parallelus*	(6)
Gastrocopta holzingeri	(64)	*Vallonia gracilicosta*	(4)
Succinea ovalis	(59)	*Discus cronkhitei*	(2)
Cochlicopa lubricella	(54)	*Nesovitrea electrina*	(2)
Vallonia costata	(53)	Immature *Vallonia*	(124)
Discus catskillensis	(51)	Immature Pupillidae	(76)
Euconulus fulvus	(48)		

Lost Hill River

Location: 96.0520 W., 47.8373 N.
Habitat Type: Floodplain Forest
Richness: 10

Habitat Group: Lowland Forest
Total Abundance: 379

Floodplain Aspen, Ash, Elm forest with thin litter over hard clay soil.

Vallonia pulchella	(59)	*Zonitoides arboreus*	(6)
Succinea ovalis	(58)	*Euconulus fulvus*	(4)
Vallonia costata	(48)	*Strobilops labyrinthica*	(4)
Nesovitrea electrina	(24)	*Hawaiia minuscula*	(3)
Discus cronkhitei	(15)	*Columella simplex*	(2)
Carychium exile	(14)	Immature Vallonia	(132)
Cochlicopa lubrica	(10)		

Marcoux WMA

Location: 96.2242 47.7985
Habitat Type: Wet Prairie
Richness: 11

Habitat Group: Lowland Grassland
Total Abundance: 688

Heavily burned wet-mesic prairie.

Vallonia gracilicosta	(137)	*Euconulus alderi*	(53)
Hawaiia minuscula	(116)	*Nesovitrea electrina*	(12)
Gastrocopta tappaniana	(91)	*Zonitoides arboreus*	(10)
Punctum minutissimum	(74)	*Oxyloma retusa*	(3)
Catinella avara	(58)	*Deroceras laeve*	(1)
Vertigo milium	(56)	Immature Pupillidae	(77)

Roseau County

Bemis Hill 1

Location: 95.4611 W., 48.7236 N.
Habitat Type: Black Ash Wetland
Richness: 22

Habitat Group: Lowland Forest
Total Abundance: 2397

Mature Black Ash, Balsam Poplar forest with dense moss-sedge groundcover and thick leaf litter layer.

Carychium exile	(388)	*Zonitoides arboreus*	(24)
Punctum minutissimum	(325)	*Nesovitrea binneyana*	(23)

Strobilops labyrinthica	(307)	*Punctum* n.sp.	(19)
Discus catskillensis	(290)	*Columella simplex*	(12)
Nesovitrea electrina	(230)	*Euconulus fulvus*	(8)
Striatura milium	(205)	*Deroceras laeve*	(4)
Carychium exiguum	(145)	*Discus cronkhitei*	(4)
Cochlicopa lubricella	(107)	*Vertigo arthuri*	(4)
Gastrocopta tappaniana	(70)	*Vertigo nylanderi*	(4)
Euconulus alderi	(63)	Immature Pupillidae	(73)
Vertigo elatior	(59)	Immature Succineidae	(2)
Vallonia gracilicosta	(31)		

Bemis Hill 2

Location: 95.4621 W., 48.7169 N.
Habitat Type: White Cedar Wetland
Richness: 15

Habitat Group: Lowland Forest
Total Abundance: 531

Mature, mesic White Cedar forest with thick leaf litter layer.

Carychium exile	(208)	*Euconulus alderi*	(8)
Striatura milium	(71)	*Zonitoides arboreus*	(4)
Discus catskillensis	(63)	*Cochlicopa lubricella*	(3)
Strobilops labyrinthica	(44)	*Vallonia gracilicosta*	(3)
Nesovitrea electrina	(34)	*Discus cronkhitei*	(2)
Punctum minutissimum	(30)	*Vertigo arthuri*	(1)
Nesovitrea binneyana	(23)	*Vertigo cristata*	(1)
Gastrocopta tappaniana	(22)	Immature Pupillidae	(14)

Duxby

Location: 96.0267 W., 48.9064 N.
Habitat Type: Oak Forest
Richness: 19

Habitat Group: Upland Forest
Total Abundance: 824

Mature Bur Oak forest with Viburnum understory and moderate to thin leaf litter over hard soil.

Nesovitrea binneyana	(208)	*Vitrina limpida*	(14)
Strobilops labyrinthica	(193)	*Euconulus fulvus*	(13)
Vallonia gracilicosta	(91)	*Cochlicopa lubricella*	(8)
Discus catskillensis	(85)	*Gastrocopta tappaniana*	(8)
Striatura milium	(50)	*Discus cronkhitei*	(3)
Succinea ovalis	(37)	*Gastrocopta pentodon*	(3)
Nesovitrea electrina	(28)	*Hawaiia minuscula*	(2)

Zonitoides arboreus	(22)	*Punctum minutissimum*	(2)
Carychium exile	(19)	*Gastrocopta holzingeri*	(1)
Vertigo arthuri	(17)	Immature Pupillidae	(20)

Hayes Lake State Park 1

Location: 95.5544 W., 48.6367 N.
Habitat Type: Maple-Basswood
Richness: 19

Habitat Group: Upland Forest
Total Abundance: 392

Ash, White Spruce, Box Elder forest on south-facing slope with llittle leaf litter over hard soil.

Cochlicopa lubricella	(72)	*Nesovitrea electrina*	(9)
Carychium exile	(49)	*Zonitoides arboreus*	(9)
Nesovitrea binneyana	(37)	*Vallonia costata*	(6)
Euconulus fulvus	(33)	*Columella simplex*	(5)
Punctum minutissimum	(32)	*Gastrocopta holzingeri*	(5)
Strobilops labyrinthica	(23)	*Cochlicopa lubrica*	(3)
Striatura milium	(18)	*Vitrina limpida*	(2)
Succinea ovalis	(17)	*Hawaiia minuscula*	(1)
Vallonia gracilicosta	(14)	Immature *Vallonia*	(45)
Vertigo arthuri	(11)	Immature *Discus*	(1)

Hayes Lake State Park 2

Location: 95.5535 W., 48.6375 N.
Habitat Type: Jack Pine Forest
Richness: 9

Habitat Group: Upland Forest
Total Abundance: 307

Deep leaf litter under Hazel scrum in xeric Jack Pine forest.

Nesovitrea binneyana	(87)	*Zonitoides arboreus*	(16)
Striatura milium	(75)	*Vertigo cristata*	(10)
Discus catskillensis	(37)	*Euconulus fulvus*	(9)
Strobilops labyrinthica	(29)	*Discus cronkhitei*	(1)
Punctum minutissimum	(21)	Immature Pupillidae	(22)

Minnesota Hill 1

Location: 95.9079 W., 48.9640 N.
Habitat Type: Tamarack Wetland
Richness: 15

Habitat Group: Lowland Forest
Total Abundance: 334

Wet-mesic Tamarack swamp forest with Alder and Bog Birch and moss-sedge dominated groundlayer.

Carychium exiguum	(117)	*Discus cronkhitei*	(4)
Punctum minutissimum	(75)	*Punctum* n.sp.	(3)
Nesovitrea electrina	(34)	*Vertigo elatior*	(3)
Striatura milium	(26)	*Columella simplex*	(2)
Gastrocopta tappaniana	(24)	*Zonitoides arboreus*	(1)
Vertigo nylanderi	(15)	Immature Pupillidae	(10)
Cochlicopa lubricella	(9)	Immature *Vallonia*	(2)
Euconulus alderi	(8)	Immature Succineidae	(1)

Minnesota Hill 2

Location: 95.9077 W., 48.9661 N.
Habitat Type: Fen
Richness: 11
Habitat Group: Lowland Grassland
Total Abundance: 303

Intermediate fen with Bog Birch, Sage Willow, Tamarack and mixture of *Sphagnum* and brown mosses.

Carychium exiguum	(93)	*Vertigo nylanderi*	(9)
Gastrocopta tappaniana	(58)	*Catinella avara*	(7)
Punctum minutissimum	(42)	*Columella simplex*	(4)
Nesovitrea electrina	(23)	*Succinea ovalis*	(1)
Euconulus alderi	(15)	*Zonitoides arboreus*	(1)
Vertigo elatior	(10)	Immature Pupillidae	(40)

Muskeg Bay

Location: 95.2121 W., 48.8839 N.
Habitat Type: Shrub Carr
Richness: 12
Habitat Group: Lowland Forest
Total Abundance: 117

Leaf litter accumulations stranded above waterline at bases of Willow shrubs in lakeshore shrub carr; with Touch-me-Not.

Zonitoides nitidus	(54)	*Catinella avara*	(3)
Cochlicopa lubrica	(19)	*Vallonia costata*	(3)
Discus cronkhitei	(14)	*Vertigo elatior*	(2)
Vertigo ovata	(9)	*Zonitoides arboreus*	(2)
Nesovitrea electrina	(5)	*Euconulus alderi*	(1)
Carychium exiguum	(4)	*Vallonia pulchella*	(1)

Roseau River WMA

Location: 96.0379 W., 48.9922 N.
Habitat Type: Tamarack Wetland
Richness: 10

Habitat Group: Lowland Forest
Total Abundance: 172

Rich, wet Tamarack-Alder swamp forest with dense moss-herb groundlayer.

Carychium exiguum	(93)	*Vertigo elatior*	(7)
Carychium exile	(27)	*Discus catskillensis*	(5)
Nesovitrea electrina	(20)	*Euconulus alderi*	(4)
Punctum minutissimum	(7)	*Deroceras laeve*	(1)
Striatura milium	(7)	*Strobilops labyrinthica*	(1)

Skime North 1

Location: 95.6022 W., 48.5944 N.
Habitat Type: Tamarack Weetland
Richness: 11

Habitat Group: Lowland Forest
Total Abundance: 733

Wet Tamarack swamp forest with Willow and Bog Birch.

Carychium exiguum	(491)	*Vertigo elatior*	(11)
Striatura milium	(61)	*Euconulus alderi*	(8)
Nesovitrea electrina	(49)	***Vertigo nylanderi***	**(5)**
Gastrocopta tappaniana	(48)	*Zonitoides arboreus*	(3)
Punctum minutissimum	(23)	Immature Pupillidae	(19)
Discus catskillensis	(11)	Immature Succineidae	(4)

Skime North 2

Location: 95.6018 48.5860
Habitat Type: Aspen Forest
Richness: 20

Habitat Group: Upland Forest
Total Abundance: 788

Aspen-White Spruce forest with Bracken groundlayer and scattered wet spots with Black Ash.

Strobilops labyrinthica	(244)	*Carychium exiguum*	(11)
Carychium exile	(154)	***Vertigo arthuri***	**(9)**
Nesovitrea binneyana	(101)	*Zonitoides arboreus*	(8)
Striatura milium	(60)	*Vitrina limpida*	(6)
Punctum minutissimum	(40)	*Striatura exigua*	(5)
Discus catskillensis	(28)	*Euconulus alderi*	(3)
Euconulus fulvus	(23)	*Vertigo elatior*	(3)

Cochlicopa lubricella	(21)	*Succinea ovalis*	(2)
Gastrocopta tappaniana	(18)	*Vertigo nylanderi*	(1)
Nesovitrea electrina	(17)	Immature Pupillidae	(20)
Columella simplex	(14)		

Skime West

Location: 95.6417 W., 48.5517 N.
Habitat Type: Jack Pine Forest
Richness: 13

Habitat Group: Upland Forest
Total Abundance: 1174

Mesic Jack Pine, Aspen, Balsam forest with Hazel understory and deep leaf litter layer over sandy soil.

Striatura milium	(329)	*Zonitoides arboreus*	(16)
Strobilops labyrinthica	(271)	*Vitrina limpida*	(3)
Discus catskillensis	(194)	*Columella simplex*	(2)
Punctum minutissimum	(135)	*Gastrocopta tappaniana*	(1)
Nesovitrea binneyana	(129)	Immature Pupillidae	(19)
Vertigo arthuri	(36)	Immature *Cochlicopa*	(5)
Euconulus fulvus	(31)	Immature Succineidae	(3)

Sprague Creek

Location: 95.7772 W., 48.9783 N.
Habitat Type: Black Spruce Wetland
Richness: 12

Habitat Group: Lowland Forest
Total Abundance: 296

Dense Black Spruce-Tamarack swamp forest with thick moss groundlayer.

Carychium exiguum	(75)	*Vertigo cristata*	(8)
Punctum n.sp.	(41)	*Vertigo nylanderi*	(7)
Striatura milium	(38)	*Discus catskillensis*	(5)
Nesovitrea electrina	(31)	*Zonitoides arboreus*	(5)
Euconulus alderi	(16)	*Columella simplex*	(4)
Vertigo elatior	(14)	Immature Pupillidae	(39)
Gastrocopta tappaniana	(13)		

Two Rivers SNA

Location: 96.3450 W., 48.6557 N.
Habitat Type: Aspen Forest
Richness: 21

Habitat Group: Upland Forest
Total Abundance: 1109

Cochlicopa lubricella	(21)	*Succinea ovalis*	(2)
Gastrocopta tappaniana	(18)	*Vertigo nylanderi*	(1)
Nesovitrea electrina	(17)	Immature Pupillidae	(20)
Columella simplex	(14)		

Skime West

Location: 95.6417 W., 48.5517 N.
Habitat Type: Jack Pine Forest
Richness: 13

Habitat Group: Upland Forest
Total Abundance: 1174

Mesic Jack Pine, Aspen, Balsam forest with Hazel understory and deep leaf litter layer over sandy soil.

Striatura milium	(329)	*Zonitoides arboreus*	(16)
Strobilops labyrinthica	(271)	*Vitrina limpida*	(3)
Discus catskillensis	(194)	*Columella simplex*	(2)
Punctum minutissimum	(135)	*Gastrocopta tappaniana*	(1)
Nesovitrea binneyana	(129)	Immature Pupillidae	(19)
Vertigo arthuri	(36)	Immature *Cochlicopa*	(5)
Euconulus fulvus	(31)	Immature Succineidae	(3)

Sprague Creek

Location: 95.7772 W., 48.9783 N.
Habitat Type: Black Spruce Wetland
Richness: 12

Habitat Group: Lowland Forest
Total Abundance: 296

Dense Black Spruce-Tamarack swamp forest with thick moss groundlayer.

Carychium exiguum	(75)	*Vertigo cristata*	(8)
Punctum n.sp.	(41)	*Vertigo nylanderi*	(7)
Striatura milium	(38)	*Discus catskillensis*	(5)
Nesovitrea electrina	(31)	*Zonitoides arboreus*	(5)
Euconulus alderi	(16)	*Columella simplex*	(4)
Vertigo elatior	(14)	Immature Pupillidae	(39)
Gastrocopta tappaniana	(13)		

Two Rivers SNA

Location: 96.3450 W., 48.6557 N.
Habitat Type: Aspen Forest
Richness: 21

Habitat Group: Upland Forest
Total Abundance: 1109

Dry to wet-mesic Aspen-Bur Oak forest with thick leaf litter layer on sand ridge.

Strobilops labyrinthica	(296)	*Vitrina limpida*	(9)
Striatura milium	(137)	*Gastrocopta contracta*	(8)
Carychium exile	(109)	*Gastrocopta tappaniana*	(8)
Euconulus fulvus	(93)	*Cochlicopa lubricella*	(7)
Vallonia gracilicosta	(86)	*Columella simplex*	(7)
Punctum minutissimum	(72)	*Vertigo elatior*	(6)
Nesovitrea binneyana	(69)	*Gastrocopta holzingeri*	(5)
Gastrocopta pentodon	(65)	*Hawaiia minuscula*	(4)
Vertigo arthuri	(38)	*Nesovitrea electrina*	(2)
Zonitoides arboreus	(32)	Immature Pupillidae	(41)
Discus catskillensis	(19)	Immature Succineidae	(1)

Warroad River

Location: 95.1346 W., 48.7325 N.
Habitat Type: Tamarack Wetland
Richness: 15

Habitat Group: Lowland Forest
Total Abundance: 355

Wet-mesic Tamarack swamp forest with dense sedge groundcover.

Striatura milium	(56)	*Gastrocopta tappaniana*	(6)
Nesovitrea electrina	(52)	*Cochlicopa lubrica*	(5)
Carychium exiguum	(49)	*Vertigo nylanderi*	(5)
Carychium exile	(47)	*Vertigo elatior*	(4)
Punctum n.sp.	(23)	*Zonitoides arboreus*	(4)
Euconulus alderi	(14)	Immature Pupillidae	(66)
Columella simplex	(12)	Immature *Discus*	(2)
Strobilops labyrinthica	(9)	Immature Succineidae	(1)

APPENDIX III.

Manuscript describing the effect of fire management on grassland land snail faunas accepted for publication in *Animal Biodiversity and Conservation*, June, 2002.

Effects of fire management on the richness and abundance of central North American grassland land snail faunas

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ABSTRACT

The land snail faunas from 72 upland or lowland grassland sites from central North America were analyzed. Sixteen of these had been exposed to fire management within the last 15 years, while the remainder had not. A total of 91,074 individuals in 72 different species were observed. Richness was reduced by approximately 30% on burned sites, while abundance was reduced by 50-90%. 1-way ANOVA of all sites (using management type as the independent variable), a full 2-way ANOVA (using management and grassland type) of all sites, and a 2-way ANOVA limited to 26 sites paired according to their habitat type and geographic location, demonstrated in all cases a highly significant (up to $p < 0.0005$) reduction in richness and abundance on fire managed sites. Contingency table analysis of individual species demonstrated that 44% experienced a significant reduction in abundance on firemanaged sites. Only six species positively responded to fire. Comparisons of fire response to the general ecological preferences of these species demonstrated that fully 72% of turfspecialists were negatively impacted by fire, while 67% of duff-specialists demonstrated no significant response. These differences were highly significant ($p=0.0006$). Thus, frequent use of fire management represents a significant threat to the health and diversity of North American grassland land snail communities. Protecting this fauna will require the preservation of site organic litter layers, which will require the increase of fire return intervals to 15+ years in conjunction with use of more diversified methods to remove woody and invasive plants.

Key words: Land snail, biodiversity, conservation, fire management, grassland, North America

INTRODUCTION

Fire has long been implicated in the maintenance of central North American grassland communities (Weaver 1954, Curtis 1959). Numerous native plant species respond to fire by increasing their growth and reproductive rates (Ehrenreich & Aikman 1963, Kucera & Koelling 1964, Towne & Owensby 1984). One of the most direct effects of prairie fire is the removal of the soil mulch layer, which has been implicated in the 'stagnation' of prairie plant communities through the delay of initial spring growth, thinning of grass stem density, and prevention of herbaceous understory development (Weaver & Rowland 1952, Kucera & Koelling 1964). Fire is also thought to limit invasion of woody and exotic plants into native prairie habitats (e.g., Pauly 1982, Roosa 1984). For these reasons, prescribed fire has become the management tool of choice by prairie conservation groups throughout the midwestern USA (Collins & Wallace 1990).

However, an increasing body of research suggests that fire is not universally beneficial all prairie biota. Fire depresses growth and reproductive rates of native C3 prairie plants (Dix 1960, Hadley 1970, Hill & Platt 1975), which make up at least 50% of the native flora north of 440 N (Stowe & Teeri 1978, Sims 1988). Fire has also been implicated in the loss and/or reduction of numerous native prairie invertebrate species including Lepidoptera, Homoptera, Hymenoptera, and Araneae (Swengel 1996, 1998; Harper et. al, 2000). The effects of such practices on prairie soil biodiversity are largely undocumented. Combustion of mulch through repeated fire episodes will remove the detritusphere, one of the most important reservoirs for soil biodiversity (Coleman & Crossley 1996). Harper et al. (2000) documented significant reductions in Collembola following Illinois prairie fires. As the soil fauna represents one of the largest species pools in terrestrial ecosystems (Behan-Pelletier & Newton 1999), the potential impacts of such processes on total site biodiversity may be large.

Although not as hyper-diverse as bacteria, fungi, nematodes, and arthropods, molluscs still represent one of the more important components of soil biodiversity (Russell-Hunter 1983). Almost 600 species are known from eastern North America (Hubricht 1985), with up to 21 taxa co-occurring within 400 cm2 microhabitats (Nekola

& Smith 1999). Most of these taxa represent generalist detritivores that live in and on dead organic material (Burch & Pearce 1990)

As almost 90% of snails occur within 5 cm of the soil surface (Hawkins et al., 1998), protection of this fauna will likely be tied to the fate of mulch layers. Disturbances such as logging, recreational or urban development, or bedrock and soil removal cause dramatic changes in woodland snail communities with duff soil surfaces (Nekola, in review A). The impact of fire, and associated detritusphere removal, on snail communities is unclear. Fire has been suggested to negatively influence the faunas of Aegean islands (Welter-Schultes & Williams 1999), Queensland fens (Stanisic 1996), and Tasmanian woodlands (Regan et al. 2001). However, Frest & Johannes (1995) state that mollusks are able to survive natural fires in northwestern North America, and Theler (1997) argues that xeric prairie faunas in Wisconsin owe their existence to frequent fires that keep grassland areas treeless. Unfortunately, no data was presented by these various authors to validate such conflicting statements.

To evaluate this issue, the richness and abundance of land snails was quantitatively compared between unburned and recently (< 15 year) burned sites in the midwestern USA. From these, the following questions will be considered: (1) Is there a significant difference in land snail community richness between burned and unburned grasslands? (2) Is there a significant difference in land snail abundance between burned and unburned grasslands? (3) What species show positive, negative, or no response to fire? What ecological factors (if any) may help explain these responses?

METHODS AND MATERIALS

Study Sites

Seventy two grassland sites were surveyed between V 96-XI 01 for terrestrial molluscs across a 850 km extent of central North America (Figure 1; Table 1). Sites are generally centered on northwestern Minnesota and northeastern Iowa. Forty-two occur in Minnesota,

25 in Iowa, and 5 in Wisconsin. Thirty-two sites represent upland habitats (including tallgrass prairie, sand prairie, and bedrock glades), while the remaining 40 are lowland sites (including wet prairie, sedge meadow, and fens). Previous use of fire management on sites was assessed by either observing carbonized woody plant stems or other debris on the ground surface, or through interviews with site managers or other knowledgeable individuals. No use of fire management was noted from 56 sites (88% of total), while 16 (22%) had been subjected to some amount of prescribed burning. Eleven of these burned sites occur in Minnesota, while the remaining five occur in Iowa. The latitude-longitude location of each site was determined using either USGS 7.5 minute topographic maps or a hand-held GPS.

Field Methods

Documentation of terrestrial gastropod faunas from each site was accomplished by hand collection of larger shells and litter sampling for smaller taxa from representative 1001000 m2 areas. Soil litter sampling was primary used as it provides the most complete assessment of grassland faunas (Oggier *et al.,* 1998). As suggested by Emberton *et al.* (1996), litter collections were made at places of high micro-mollusc density, with a constant volume (approximately 4 liters) being gathered from each site. Sampling was generally comprised of: (1) small blocks (ca. 125 cm^3) of turf; (2) loose soil and leaf litter accumulations under or adjacent to shrubs, cobbles, boulders, and/or hummocks; and (3) other microsites supporting relatively thick mulch layers.

Laboratory Procedures

Samples were slowly and completely dried in either a low-temperature soil oven (ca. 80-950 C) or in full sun in a greenhouse. Dried samples were then soaked in water for 3-24 hours, and subjected to careful but vigorous water disaggregation through a standard sieve series (ASTME 3/8" (9.5 mm), #10 (2.0 mm), #20 (0.85), and #40 (0.425 mm) mesh screens). Sieved sample fractions were then dried and passed again through

the same sieve series. These dry, resorted fractions were hand picked against a neutral-brown background. All shells and shell fragments were removed.

All identifiable shells from each site were assigned to species (or subspecies) using the author's reference collection and the Hubricht Collection at the Field Museum of Natural History (FMNH), with the total number of shells per species per site being recorded. The total number of unassignable, immature individuals was also counted from each site. All specimens have been catalogued and are housed in the author's collection at the University of Wisconsin - Green Bay. Nomenclature generally follows that of Hubricht (1985), with updates and corrections by Frest (1990, 1991) and Nekola (in *review* B). The general ecological preferences (turf specialist, duff-specialist or generalist) of each species is based upon analyses presented in Nekola (in *review A).*

Statistical Procedures

Differences in species richness and total shell abundance between burned and unburned grassland sites were analyzed via ANOVA. Initially, 1-way ANOVAs were preformed on the entire dataset. However, the effect of fire may be obscured in this analysis due to confounding effects of habitat type and geographic location. To help control for this, two additional sets of ANOVAs were conducted. First, full 2-way ANOVAs were calculated for all sites using grassland type (upland vs. lowland) and management history (burned vs. unburned) as the independent variables. Second, 13 pairs of sites representing closely similar habitats within the same geographic region, but differing in their fire management history, were selected. These site pairs are (first site is burned, second is unburned): Malmberg Prairie vs. Sandpiper Prairie; Pankratz Mesic Prairie vs. Radium NE; Pankratz Low Prairie vs. Bjornson WMA; Pankratz Fen vs. Faith South; Marcoux WMA vs. Cyr Creek; East Park WMA vs. Goose Lake; Felton Fen 1 vs. Ogema West; Waubun SE vs. Eastlund Lake; Chicog vs. Tansen; Beemis Creek vs. Hampton East; Fayette vs. Decorah Glade; Baty Glade vs. Canton Glade; Brayton-Horsley vs. Stapleton Church. A 2-way ANOVA without interaction was then

calculated for these sites, with site pair identity and management type representing independent variables.

The central tendencies in these various relationships were graphically represented via box plots. In box plots, the central line represents the median of the sample, the margins of the box represent the interquartile distances, and the fences represent 1.5 times the interquartile distances. For data having a Gaussian distribution, approximately 99.3% of the data will fall inside of the fences (Velleman & Hoaglin 1981). Outliers falling outside of the fences are shown with asterisks.

The average number of individuals per species per site was determined for burned uplands, unburned uplands, burned lowlands, and unburned lowlands. The proportion of each species in the total community was calculated for each management/habitat type. These proportions were placed in rank order, and plotted vs. log-transformed frequency to create dominance-diversity curves (Whittaker 1975).

The response of individual species to fire was analyzed through log-linear modelling, as predicted values in the associated contingency table were sparse (< 5) in more than one-fifth of cells (Zar 1984). The total number of individuals within all burned or unburned sites was compared to a null expectation of equal occurrence frequency. This null expectation was calculated by assigning 88% of all encountered individuals to unburned sites, with the remaining 22% being assigned to burned sites. A two-tailed significance threshold was employed so that species with positive and negative responses to fire could both be identified. As these analyses were repeated for each species, a Bonferroni correction was used to adjust this significance threshold. Differences between fire responses across the three general ecological preference types were documented via a contingency table, with significance being estimated using both log-linear modelling and Fisher's Exact test.

RESULTS

These grassland habitats were generally found to support a diverse and abundant land snail fauna. A total of 91,074 individuals in 72 different species were recovered from the 72 surveyed sites (Tables 1, 2). The number of species per 41 litter sample per

site ranged from two (Chicog gravel prairie) to 24 (Twin Pines Farm sandstone glade). Average richness ranged from roughly 15 in upland sites, to 17 in lowland. Snail abundance per site ranged from 6 (Point Beach State Forest dunes) to 5001 (Ogema West fen). Average abundance ranged from roughly 500 in upland sites to 2000 in lowlands.

One-way ANOVA, using all sites, demonstrated that both species richness ($p=0.001$) and abundance ($p=0.008$) were significantly lower on sites that have experienced fire management (Figure 2). Median species richness was approximately 18 on unburned vs. 12 on burned sites. Likewise, median shell abundance was 1000 on unburned vs. 300 on burned sites.

Full 2-way ANOVA, using all sites and considering both management type and habitat type (upland vs. lowland) as independent variables, demonstrated a highly significant ($p=0.002$) reduction (approximately 30%) in species richness in both upland and lowland sites (Figure 3). Habitat type and the interaction between habitat and fire history were not significant predictors ($p=0.209$ and $p=0.628$, respectively). Likewise, a significant ($p=0.010$) reduction in shell abundance (50-70%) was noted on burned sites (Figure 3). In this case, however, habitat type was a more significant ($p < 0.0005$) predictor, with lowlands having 410 times the number of shells as uplands. Additionally, a marginally significant ($p=0.088$) interaction between management and habitat was observed, with the reduction appearing to be roughly 50% greater in lowlands.

Two-way ANOVA restricted to the 26 paired sites (Figure 4) demonstrated that even after blocking of variation due to site pair identity, a significant reduction in richness ($p < 0.0005$) and abundance ($p=0.015$) still occurred on fire-managed sites.

Comparison of dominance-diversity diagrams for these sites (Figure 5) demonstrates that both burned upland and lowland sites have truncated curves, with the rarest 40-50% of species being much less common as compared to unburned sites. However, the more common species appear to have largely similar dominancediversity diagrams.

Contingency table analysis of individual species responses to fire (Table 2) indicate that 32 (44%) experience a significant reduction in abundance on fire-managed

sites, even following use of a Bonferroni-corrected twotailed significance threshold (p=0.000347). Only six species (8%) demonstrated positive responses to fire, while the remaining 34 (47%) demonstrated no significant changes in population size. Contingency table analysis of ecological preference vs. fire response indicated that fully 72% of turf-specialists were negatively impacted by fire (Table 3). However, only 22% of duff-specialists exhibited negative responses. While 67% of duff-specialists demonstrated no significant response to fire only 24% of turf-specialists were unaffected. Generalist species demonstrated little discernable trend to fire, with seven decreasing, two increasing, and five with no response. Log-likelihood ratio and Fisher's Exact tests both indicated these differences as being highly significant ($p = 0.0006$ and $p = 0.004$, respectively).

DISCUSSION

These data clearly indicate that fire management causes significant reductions in land snail community richness and abundance in both upland and lowland grasslands throughout a significant section of the tallgrass prairie biome in central North America. At a species-level, fire most strongly impacts the rarest species, and causes significant population reductions in 44% of the 72 encountered taxa. These negative impacts were most strongly felt in turfspecialists, where almost 75% experienced significant reductions. Thus, statements regarding the benign nature of fire on snail populations (Frest & Johannes 1995), and the beneficial impact of fire on North American grassland faunas (Theler 1997) can be proven false. Rather, frequent use of fire management appears to represent a significant threat to the health and diversity of North American grassland land snails.

It is not possible through these analyses to definitively identify the factors that directly lead to these impacts. However, at least part of the answer must lay in grassland detritusphere removal. This will lead to direct mortality, as the great majority of land snails are limited to this layer (Hawkins *et al.* 1998). This may also have a negative impact as land snail abundance (Berry 1973), diversity (Cain 1983, Locasciulli & Boag 1987), and composition (Cameron & Morgan-Huws 1975, Baur *et al.* 1996, Barker & Mayhill 1999) is often positively correlated with litter depth. Redevelopment of an

equilibrium thickness of organic detritus takes at least five years in southern Plains grasslands (Kucera & Koelling 1964), with even longer intervals being required in more northern locations (Hill & Platt 1975). The optimal interval between fires for land snails might be even longer, depending upon the time required for more refractory plant debris (such as lignified grass stems) to break down, allowing a complete suite of decompositional microhabitats to develop. Litter architecture is known to effect snail community composition in forests of Virginia (Burch 1956), British Columbia (Cameron 1986), and Puerto Rico (Alvarez & Willig 1993) and grasslands of England (Young & Evans 1991). It should thus not be surprising that in the current data set, sites burned up to 15 years ago have maintained lowered land snail richness and abundance as compared to unburned sites.

As grassland land snails presumably evolved in conjunction with natural fire regimes, it is also intriguing the note that turf-specialists experienced the most severe negative impacts to fire. If fire was a common process structuring central North American grasslands, evolution should have selected for individuals that were more tolerant of, or favored by, this disturbance: Like other native grassland invertebrate groups (Swengel 1996, Harper *et al.* 2000), land snails in the presettlement landscape may have been able to tolerate fires by being able to easily recolonize from source pools in adjacent unburned areas. Even when such adjacent source pools are present, recolonization may take over a dozen years (Mand *et al.* 2001). In modern landscapes, where grasslands are highly fragmented and surrounded by agricultural, urban, or forest habitats, such recolonization has become much more difficult. Thus, turf-specialist taxa may continue to decrease in burned grasslands due to a lack of recolonization sources, while generalist and duff-specialist woodland taxa, which are more common in the surrounding landscape, may be able to maintain their populations through mass effect (Shmida & Ellner 1984).

The depression of land snail richness and abundance following fire episodes, the length of time required to redevelop a mature detritusphere, and the greater sensitivity of turfspecialist taxa to fire casts doubt on the wide-held belief (e.g., Pauly 1985) that North

American grasslands should be burned at 2-6 year intervals. Rather, these data support the contention that presettlement return intervals ranged between 20-30 years (Sims 1988). These data also strongly suggest that other factors, such as large herbivore grazing (Collins *et al.* 1998) and periodic drought (Borchert 1950), may have played essential roles in keeping prairies treeless, as these processes do not lead to the wholesale detritusphere destruction.

Protecting the health of North American grassland land snail populations will require the preservation of mulch layers on sites. Such efforts will also help protect a large percentage of the entire grassland soil biota. The detritusphere can only be protected if more realistic fire return intervals (20-30 years) are adopted by conservation agencies, and used in conjunction with more diversified approaches towards woody and invasive plant removal. Activities like grazing, haying, and hand cutting/pulling will not cause widespread removal of the detritusphere, and should thus be more compatible with land snail conservation.

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FIGURE LEGENDS

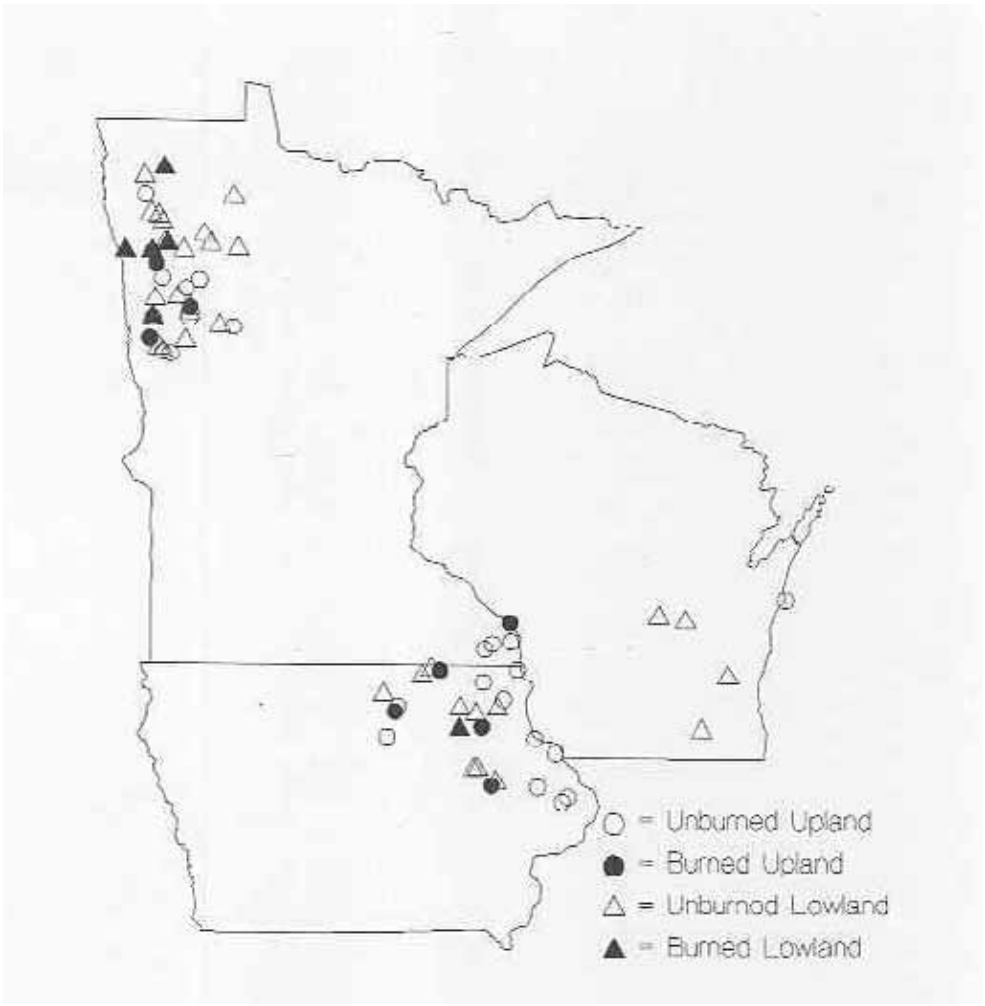
Figure 1: Map of study region, showing location of surveyed grassland sites.

Figure 2. Box-plot diagram of the response of species richness and abundance to management type on all sampled sites.

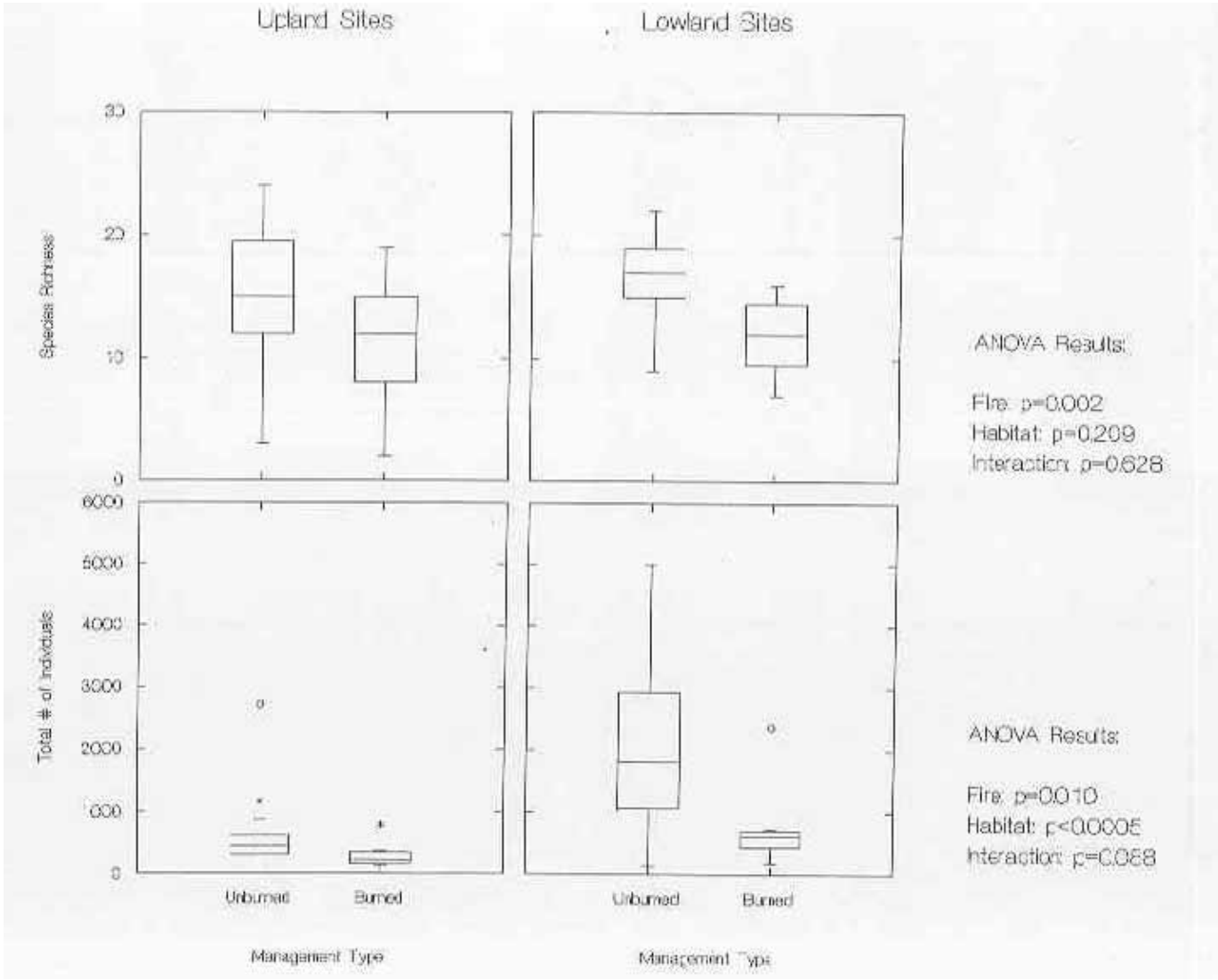
Figure 3: Box-plot diagram of the response of species richness and abundance to management and habitat type on all sampled sites.

Figure 4: Box-plot diagram of the response of species richness and abundance to management on 26 sites paired by habitat type and geographic location.

Figure 5: Dominance-diversity curve for upland/lowland sites which have been burned/unburned.


○ = Unburned Upland
● = Burned Upland
△ = Unburned Lowland
▲ = Burned Lowland

Total # of Individuals
6000
5000
4000
3000
2000
1000
0
Unburned
Burned
Management Type
p = 0003
Cheatgrass Richness
30
20
10
0
Unburned
Burned
Management Type
p = 0001


Upland Sites
Lowland Sites
Species Richness
Total # of Individuals
Unburned
Burned
Management Type
ANOVA Results:
Fire: p=0.002
Habitat: p=0.209
Interaction: p=0.628
ANOVA Results:
Fire: p=0.010
Habitat: p<0.0005
Interaction: p=0.088

Species Richness
30
20
10
0
Unburned
Burned
Management Type
ANOVA Results:
pairs: p=0.001
fire: p<0.0005
Total # of individuals
6000
5000
4000
3000
2000
1000
0
Unburned
Burned
Management Type
ANOVA Results
pairs: p=0.009
fire: p=0.015

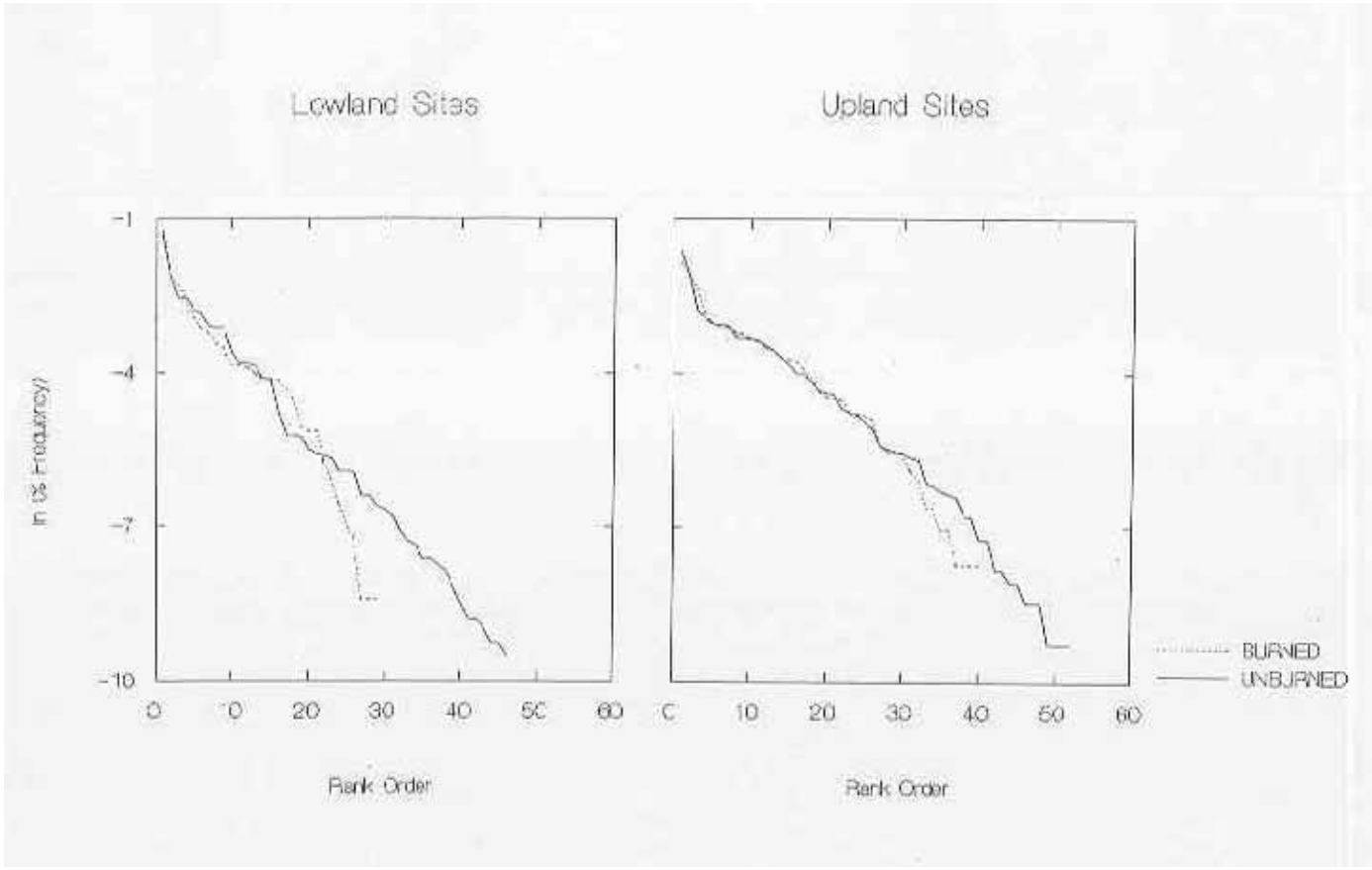

Lowland Sites
Upland Sites
ln (% Frequency)
-1
-4
-7
-10
0
10
20
30
40
50
60
Rank Order
BURNED
UNBURNED

Table 1: Location, grassland type, managment, species richness and total number of collected individuals from sample sites.

State / County / Site Name	Location	Grassland Type	Management	Richness	Individuals
IOWA					
Allamakee County					
Fish Farm Mounds	91° 17' 12" W., 43° 27' 13" N.	Upland	Unburned	21	632
Williams Creek 3	91° 29' 1" W., 43° 8' 1" N.	Upland	Unburned	23	2708
Bremer County					
Brayton-Horsley Fen	92° 6' 29" W., 42° 48' 36" N.	Lowland	Burned	16	627
Buchanan County					
Rowley Fen	91° 51' 7" W., 42° 22' 27" N.	Lowland	Unburned	16	3217
Rowley North Fen	91° 51' 3" W., 42° 22' 35" N.	Lowland	Unburned	17	3231
Rowley West Fen	91° 54' 40" W., 42° 22' 15" N.	Lowland	Unburned	22	2250
Cerro Gordo County					
Buffalo Slough	93° 11' 11" W., 43° 10' 36" N.	Lowland	Unburned	19	4770
Chickasaw County					
Stapelton Church Fen	92° 6' 14" W., 43° 1' 35" N.	Lowland	Unburned	18	1065
Clayton County					
Postville Fen	91° 33' 59" W., 43° 2' 3" N.	Lowland	Unburned	12	252
Turkey River Mounds	91° 2' 11" W., 42° 42' 46" N.	Upland	Unburned	22	870
Clinton County					
Maquoketa South	90° 39' 5" W., 42° 1' 12" N.	Upland	Unburned	12	310
Dubuque County					
Roosevelt Road	90° 44' 30" W., 42° 32' 55" N.	Upland	Unburned	18	375
Fayette County					
Fayette	91° 47' 28" W., 42° 50' 11" N.	Upland	Burned	13	254
Turner Creek 1 Fen	91° 52' 11" W., 42° 58' 15" N.	Lowland	Unburned	16	1071
Floyd County					
Beemis Creek	93° 1' 18" W., 42° 59' 39" N.	Upland	Burned	8	192
Juniper Hill	92° 59' 2" W., 43° 3' 10" N.	Upland	Unburned	12	206
Franklin County					
Hampton East	93° 8' 13" W., 42° 43' 42" N.	Upland	Unburned	15	381
Howard County					
Hayden Prairie	92° 23' 4" W., 43° 26' 30" N.	Upland	Burned	12	132
Staff Creek Fen	92° 30' 34" W., 43° 26' 41" N.	Lowland	Unburned	15	1599
Jackson County					
Hamilton Glade	90° 34' 9" W., 42° 4' 23" N.	Upland	Unburned	15	340
Jones County					
Canton Glade	90° 59' 52" W., 42° 10' 46" N.	Upland	Unburned	19	446
Linn County					
Baty Glade	91° 39' 14" W., 42° 11' 44" N.	Upland	Burned	16	345
Paris Fen	91° 35' 42" W., 42° 13' 40" N.	Lowland	Unburned	12	1254
Mitchell County					
Stone School Fen	92° 38' 11" W., 43° 22' 49" N.	Lowland	Unburned	18	2926

Table 1: cont.

State / County / Site Name	Location	Grassland Type	Management	Richness	Individuals
Winneshiek County					
Decorah Glade	91° 46' 11" W., 43° 18' 55" N.	Upland	Unburned	18	605
MINNESOTA					
Becker County					
Audubon South Fen	95° 58' 47" W., 46° 49' 58" N.	Lowland	Unburned	15	1816
Callaway North	95° 55' 22" W., 47° 3' 57" N.	Upland	Unburned	19	362
Greenwater Lake Fen	95° 29' 59" W., 46° 59' 20" N.	Lowland	Unburned	20	2132
Ogema West Fen	95° 55' 59" W., 47° 6' 32" N.	Lowland	Unburned	16	5001
Straight Lake	95° 18' 40" W., 46° 58' 40" N.	Upland	Unburned	13	281
Beltrami County					
Fourtown Fen	95° 18' 21" W., 48° 15' 56" N.	Lowland	Unburned	14	1403
Clay County					
Barnesville WMA	96° 17' 34" W., 46° 43' 5" N.	Upland	Unburned	11	469
Barnesville WMA Fen	96° 17' 38" W., 46° 43' 9" N.	Lowland	Unburned	13	436
Bjornson WMA	96° 21' 24" W., 46° 45' 44" N.	Lowland	Unburned	14	436
Bluestem Prairie	96° 28' 45" W., 46° 51' 18" N.	Upland	Burned	15	371
Felton Prairie 1 Fen	96° 26' 21" W., 47° 3' 51" N.	Lowland	Burned	15	2370
Felton Prairie 2 Fen	96° 26' 20" W., 47° 4' 0" N.	Lowland	Unburned	14	3131
Felton Prairie	96° 26' 11" W., 47° 3' 34" N.	Upland	Unburned	5	63
Tansen	96° 11' 17" W., 46° 42' 14" N.	Upland	Unburned	10	146
Clearwater County					
Bagley Lake Fen	95° 14' 35" W., 47° 45' 41" N.	Lowland	Unburned	9	126
Filmore County					
Vesta Creek	91° 45' 0" W., 43° 40' 5" N.	Upland	Unburned	21	1151
Houston County					
Twin Pines Farm	91° 22' 45" W., 43° 44' 48" N.	Upland	Unburned	24	591
Yucatan Twp.	91° 38' 28" W., 43° 43' 23" N.	Upland	Unburned	20	765
Mahnomen County					
Eastlund Lake	95° 47' 5" W., 47° 26' 41" N.	Upland	Unburned	13	490
Mahnomen North	95° 58' 8" W., 47° 21' 27" N.	Upland	Unburned	18	806
Waubun SE	95° 54' 55" W., 47° 9' 57" N.	Lowland	Unburned	18	2915
Waubun SE	95° 55' 4" W., 47° 10' 5" N.	Upland	Burned	8	220
Marshall County					
East Park WMA	96° 16' 44" W., 48° 31' 57" N.	Lowland	Burned	14	735
Florian WMA	96° 33' 21" W., 48° 26' 33" N.	Lowland	Unburned	17	3923
Radium NE	96° 32' 38" W., 48° 16' 49" N.	Upland	Unburned	12	493
Norman County					
Faith South	96° 5' 12" W., 47° 15' 42" N.	Lowland	Unburned	16	3047
Prairie Smoke Dunes	96° 18' 22" W., 47° 27' 44" N.	Upland	Unburned	3	19
Sandpiper Prairie	96° 24' 22" W., 47° 14' 43" N.	Lowland	Unburned	12	1261

Table 1: cont.

State / County / Site Name	Location	Grassland Type	Management	Richness	Individuals
Pennington County					
Goose Lake	96° 27' 44" W., 48° 5' 37" N.	Lowland	Unburned	17	996
Higenbotham WMA	96° 17' 41" W., 48° 0' 22" N.	Lowland	Unburned	22	1114
Sanders Fen	96° 21' 9" W., 48° 3' 52" N.	Lowland	Unburned	15	2218
Polk County					
Chicog Prairie	96° 23' 14" W., 47° 35' 53" N.	Upland	Burned	2	153
Erskine North	96° 0' 3" W., 47° 44' 17" N.	Lowland	Unburned	19	741
Gulley Fen	95° 37' 22" W., 47° 48' 13" N.	Lowland	Unburned	19	2032
Malmberg Prairie	96° 49' 25" W., 47° 43' 52" N.	Lowland	Burned	7	563
Pankratz Prairie	96° 26' 37" W., 47° 43' 23" N.	Lowland	Burned	12	314
Pankratz Prairie	96° 26' 31" W., 47° 43' 23" N.	Upland	Burned	11	159
Pankratz Prairie	96° 26' 48" W., 47° 43' 9" N.	Lowland	Burned	7	190
Red Lake County					
Crane WMA	95° 42' 49" W., 47° 53' 27" N.	Lowland	Unburned	15	425
Cyr Creek	96° 16' 12" W., 47° 48' 10" N.	Lowland	Unburned	22	1845
Marcoux WMA	96° 13' 27" W., 47° 47' 55" N.	Lowland	Burned	12	688
Winona County					
Great River Bluffs	91° 23' 28" W., 43° 56' 53" N.	Upland	Burned	19	788
WISCONSIN					
Green Lake County					
Berlin Fen	88° 54' 20" W., 43° 57' 47" N.	Lowland	Unburned	20	3454
Manitowoc County					
Point Beach St. Forest	87° 30' 40" W., 44° 11' 52" N.	Upland	Unburned	4	6
Walworth County					
Bluff Creek Fen	88° 40' 54" W., 42° 48' 2" N.	Lowland	Unburned	20	1106
Washington County					
Allenton Fen	88° 18' 25" W., 43° 22' 42" N.	Lowland	Unburned	20	2858
Waushara County					
Bass Lake Fen	89° 16' 59" W., 44° 0' 16" N.	Lowland	Unburned	19	1466

Table 2. List of encountered species, with their average abundances from burned and unburned sites. P-values are based on log-likelihood ratio tests, with the two-tailed significance threshold being lowered to $p=0.000347$ to account for the 72 tested species. General ecological preferences are based on Nekola (in review). Turf-specialists represent those species demonstrating at least a $p<0.05$ preference to sites with a friable upper A soil horizon supporting few living plant roots. Turf specialists represent those species demonstrating at least a $p<0.05$ preference to sites with an upper A soil horizon that is bound together with living plant roots. Species without preferences were too infrequently encountered by Nekola (in review) to be statistically assigned.

Species	Average Abundance Unburned	Burned	p-value	Ecological preference
Negative Response				
Carychium exiguum (Say, 1822)	273.607	90.250	0.0000000	Turf
Carychium exile H.C.Lea, 1842	5.196	0.000	0.0000000	Duff
Catinella exile (Leonard, 1972)	58.446	1.625	0.0000000	Turf
Catinella 'vermeta'	1.482	0.000	0.0000001	Turf
Deroceras laeve (Müller, 1774)	4.036	1.188	0.0000050	Generalist
Discus cronkhitei (Newcomb, 1865)	16.143	5.000	0.0000000	Generalist
Euconulus alderi (Gray, 1840)	43.054	8.375	0.0000000	Turf
Gastrocopta contracta (Say, 1822)	21.232	5.875	0.0000000	Generalist
Gastrocopta holzingeri (Sterki, 1889)	36.196	17.938	0.0000000	Duff
Gastrocopta pentodon (Say, 1821)	9.661	4.875	0.0000072	Duff
Gastrocopta procera Gould, 1840)	2.304	0.000	0.0000000	Turf
Gastrocopta rogersensis Nekola & Coles, 2001	5.518	0.062	0.0000000	Turf
Gastrocopta similis (Sterki, 1909)	21.518	4.125	0.0000000	Turf
Gastrocopta tappaniana (C.B. Adams, 1842)	112.929	33.375	0.0000000	Turf
Hawaiia minuscula (A. Binney, 1840)	36.286	23.062	0.0000000	Generalist
Helicodiscus n.sp.	1.071	0.062	0.0001509	Turf
Nesovitrea binneyana (Morse, 1864)	1.500	0.000	0.0000001	Duff
Nesovitrea electrina (Gould, 1841)	80.179	22.688	0.0000000	Turf
Oxyloma retusa (I. Lea, 1834)	21.268	8.750	0.0000000	Turf
Pomatiopsis lapidaria (Say, 1817)	1.196	0.000	0.0000021	--
Punctum minutissimum (I.Lea, 1841)	26.286	10.500	0.0000000	Duff
Punctum n.sp.	41.982	12.625	0.0000000	Turf
Punctum vitreum H.B. Baker, 1930	16.536	2.812	0.0000000	Duff
Stenotrema leai leai (A. Binney)	2.696	0.375	0.0000004	Turf
Striatura milium (Morse, 1859)	0.714	0.000	0.0002470	Generalist
Strobilops affinis Pilsbry, 1893	74.911	4.312	0.0000000	Turf
Triodopsis multilineata (Say, 1821)	1.571	0.062	0.0000016	Generalist
Vallonia pulchella (Müller, 1774)	23.321	11.688	0.0000000	Turf
Vertigo elatior Sterki, 1894	41.875	5.875	0.0000000	Turf
Vertigo milium (Gould, 1840)	59.357	36.375	0.0000000	Turf
Vertigo morsei Sterki, 1894	3.589	0.375	0.0000000	Turf
Vitrina limpida Gould, 1850	1.143	0.000	0.0000035	Generalist

Table 2: cont.

Species	Average Abundance Unburned	Burned	p-value	Ecological preference
No Response				
Anguispira alternata (Say, 1817)	0.018	0.000	0.5622176	Duff
Catinella avara (Say, 1824)	7.286	8.000	0.5185276	Turf
Cochlicopa lubrica (Müller, 1774)	0.464	0.000	0.0031253	Duff
Cochlicopa lubricella (Porro, 1838)	1.714	1.938	0.6798546	Generalist
Columella simplex (Gould, 1841)	0.071	0.188	0.4068651	Duff
Discus catskillensis (Pilsbry, 1898)	0.357	0.000	0.0095467	Duff
Euconulus fulvus (Müller, 1774)	3.429	1.625	0.0040433	Duff
Euconulus polygyratus (Pilsbry, 1899)	0.018	0.000	0.5622176	Duff
Gastrocopta abbreviata (Sterki, 1909)	0.000	0.062	0.2039785	–
Gastrocopta armifera (Say, 1821)	1.232	1.188	0.9197258	Generalist
Glyphyalinia indentata (Say, 1823)	2.732	3.250	0.4543545	Duff
Haplotrema concavum (Say, 1821)	0.411	0.000	0.0054455	Generalist
Hawaiia n.sp.	2.571	1.750	0.1616094	Turf
Helicodiscus inermis H.B.Baker, 1929	0.679	1.812	0.0089186	–
Helicodiscus parallelus (Say, 1817)	5.393	6.438	0.2831711	Generalist
Helicodiscus shimeki Hubricht, 1962	0.286	0.000	0.0204383	Duff
Helicodiscus singleyanus (Pilsbry, 1890)	0.375	1.125	0.0247064	Generalist
Hendersonia occulta (Say, 1831)	0.036	0.062	0.7606162	Duff
Mesodon clausus clausus (Say, 1821)	0.054	0.000	0.3154693	Duff
Oxyloma peoriensis (Wolf, in Walker, 1892)	0.125	0.000	0.1251903	–
Pupoides albilabris (C.B. Adams, 1821)	8.393	7.062	0.2324971	Turf
Stenotrema barbatum (Clapp, 1904)	0.107	0.000	0.1557229	Duff
Stenotrema fraternum fraternum (Say, 1824)	0.054	0.062	0.9262276	Duff
Succinea indiana Pilsbry, 1905	0.000	0.188	0.0277912	–
Succinea ovalis Say, 1817	0.143	0.188	0.7834904	Duff
Triodopsis alleni (Wetherby in Sampson, 1883)	0.071	0.000	0.2464148	Duff
Vallonia gracilicosta Reinhardt, 1883	11.500	11.062	0.7459095	Duff
Vertigo arthuri (von Martens, 1884)	0.643	0.000	0.0005065	–
Vertigo gouldi (A. Binney, 1843)	0.018	0.000	0.5622176	Duff
Vertigo nylanderi Sterki, 1909	0.036	0.000	0.4124393	Turf
Vertigo ovata Say, 1822	5.750	4.000	0.0472312	Turf
Vertigo tridentata Wolf, 1870	0.375	0.062	0.0738709	Duff
Zonitoides arboreus (Say, 1816)	4.143	4.625	0.5650976	Duff
Zonitoides nitidus (Müller, 1774)	0.464	0.000	0.0031253	Turf
Positive Response				
Gastrocopta corticaria (Say, 1816)	0.732	3.500	0.0000003	Duff
Strobilops labyrinthica (Say, 1817)	9.661	22.375	0.0000000	Duff
Vallonia costata (Müller, 1774)	1.804	6.438	0.0000000	Generalist
Vallonia parvula Sterki, 1892	8.250	13.250	0.0001267	Turf
Vallonia perspectiva Sterki, 1892	2.143	5.625	0.0000055	Duff
Vertigo pygmaea (Draparnaud, 1801)	0.000	0.562	0.0001385	Generalist

Table 3. Contingency table analysis of fire response vs. general ecological preferences.

Fire Response	Ecological Preferences		
	Turf	Duff	Generalist
Negative Response	18	6	7
No Response	6	18	5
Positive Response	1	3	2

Log-likelihood Ratio: $p=0.000634$ Fisher's Exact Test: $p=0.004$